ISIS

INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM

HEART ATTACK

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HEART ATTACK

ANNOTATED TEACHER'S EDITION

Ginn and Company

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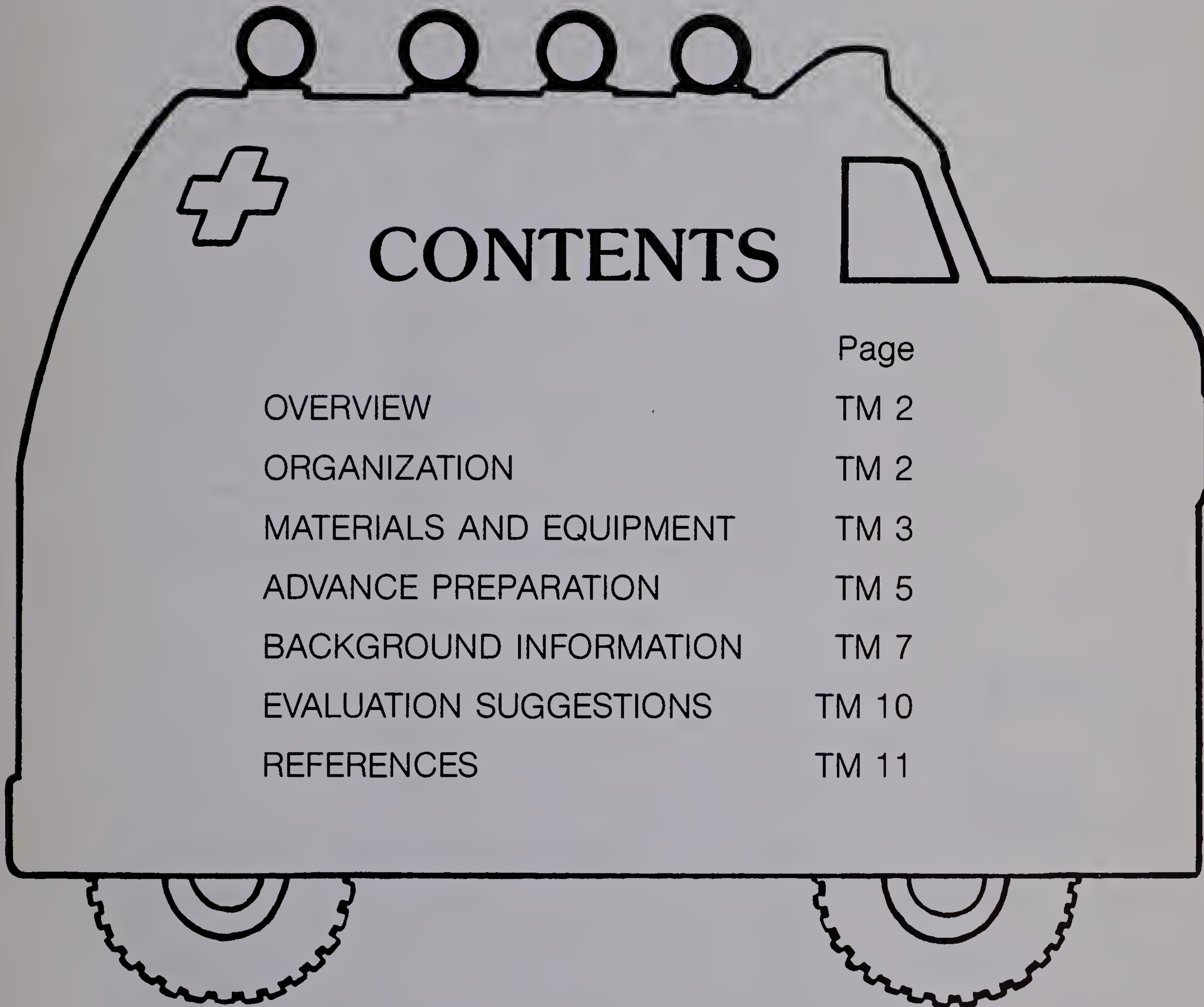


CONTENTS

Heart Attack is of vital concern to everyone because it deals with life and death. Students are made aware early in the minicourse that diseases of the heart and blood vessels are the Number 1 killer in the United States today. The myth that heart attack only strikes middle-aged men is dispelled. While males between the ages of 30 and 59 have a higher rate of heart attacks than females in the same age range, this difference disappears from age 60 on. Some social commentators believe that as women begin taking over a wider range of occupational roles, their incidence of heart attack will equal that of men. What is most relevant for this minicourse is that the number of heart attacks among young people has also been on the rise.

The approach of *Heart Attack* is preventive. Everyone can do something to prevent heart attack, and the time to begin is *now*. Students learn what the risk factors are and how to reduce these factors in their own life. They learn what happens in the body during a heart attack and stroke and how these diseases are treated. They learn emergency measures to use if confronted with a possible heart attack victim.

Because of its intimate connection to the heart, the human circulatory system is discussed in detail. Students do activities in the structure, function, and pathology of the circulatory system.

This minicourse can be used as an introduction to a health curriculum or as a foundation for further work in physiology or biology. However it is used, *Heart Attack* has an urgency for every student.

This minicourse contains eleven activities in the core section, four in the advanced section, and five in the excursion section. Except for the planning activities, which must come first, the activities in each section may be done in any order.

Emphasizing heart attack and stroke, about half of the core activities deal with diseases of the circulatory system. The students investigate the causes, symptoms, and treatments of the major diseases, including a look at contributory life-style and hereditary factors. Other core activities center on the normal structure and function of the circulatory system — the heart, the blood vessels, the blood, and the meaning and measurement of blood pressure.

The advanced activities deal with the mechanism for blood clotting, the control of blood flow through the heart, and the causes of diastolic and systolic pressures.

In the excursions, students have an opportunity to examine their own blood and to locate some of their own vein valves. Students may also choose activities on how to prevent blood loss in emer-

gency situations and how to tell whether a collapsed person is dead or unconscious.

Cassette Tape

The cassette tape for *Heart Attack* is an integral part of the minicourse. The tape has three bands, accompanying Core Activities 5 and 11 and Advanced Activity 14 of the student booklet.

The tape band for *Activity 5: Heart Attack—Care and Treatment* is based on an actual interview with a cardiologist. The interviewer asks questions about how to treat a person who has had — or who is suspected of having had — a sudden heart attack. The doctor explains what happens to the patient in the ambulance, in the hospital, and after the patient is released to go home. The interview also deals with the importance of the patient's life-style.

The tape band for *Activity 11: Heart in Action* deals with the structure and function of the heart. Students learn about the parts of the heart and how blood is supplied to all parts of the body. The tape is designed to accompany the illustrations in the student booklet.

The tape band for *Activity 14: Heart Valves* contains a detailed description of how the valves function. Here again the tape goes along with the illustrations in the student booklet. Following the tape enables the students to answer the questions in the activity.

The following chart represents an estimate of needs based on "student units." The student unit may be one student working alone, two students working as partners, or several students working as a group. The size of the student unit will depend on the nature of the activity and on the availability of materials and equipment.

QUANTITY PER STUDENT UNIT	ITEMS	ACTIVITIES			NO. UNITS THAT CAN SHARE
		Core	Advanced	Excursion	
	Consumable				
10 ml	Alcohol, isopropyl, 70%			18	
3	Cotton balls, sterile			18	

Materials and Equipment (Continued)

QUANTITY PER STUDENT UNIT	ITEMS	ACTIVITIES			NO. UNITS THAT CAN SHARE
		Core	Advanced	Excursion	
	Consumable				
1	Lancet, sterile blood, disposable			18	
1	Toothpick			18	
1	Toweling, paper or cloth	6			
5 ml	Water, distilled			18	
3 drops	Wright's stain			18	
	Nonconsumable				
1	Beaker, 250-ml or smaller	6		18	10
1	Cassette player, with headphones, if possible	5,11	14		5
1	Cassette tape for *Heart Attack*	5,11	14		5
1	Dropper, medicine	6		18	10
1	†Goldfish, live, or guppy, minnow, or molly	6			5
1	Handkerchief or cloth (for constricting band)			19	15
1	Microscope, compound	3,6		18	5
1	Petri dish, 100-mm	6			5
1	Rubber band, wide		13		6
1	Slide, prepared, human whole blood	3			5
2	Slides, microscope			18	10
1	Sphygmomanometer	9			10
1	Stethoscope	9			10
1	Timepiece, with second hand	8,9			5
1	*Resource Unit 1*	8			6
1	*Resource Unit 2*	2,9			6
1	*Resource Unit 3*	3,6		18	6

†A frog may be substituted for the fish; for alternative setup and materials, see "Activity 6 Alternative" under Advance Preparation on Page TM 6.

Activity 3 Core Page 13

If you do not have prepared blood slides (Wright's stained), try to get them from local hospitals or laboratories. Most of these institutions throw their slides away and are quite willing to give them to schools. Alternately, you can make your own blood slides following the directions given in Excursion Activity 18.

Activity 5 Core Page 23

Familiarize yourself with the medical emergency services available in your community. Find out what kind of equipment is available for heart-attack victims in the ambulance. Determine the facilities for intensive care treatment in the hospital.

You may want to arrange for a field trip for a group of students to a local hospital that is well equipped for emergency service. You might also want to invite a representative from the hospital or a staff cardiologist to speak to the group on emergency services.

The cassette tape for this activity consists of an interview with a cardiologist, who points out that the first four minutes are crucial if the patient is to survive a heart attack. During this time the primary goal is to keep the heart beating. If the heart stops, brain damage can occur. An electronic hook-up is set up between the patient and a monitor in the hospital emergency room, and treatment is started immediately.

It is important that students realize that a heart attack need not be fatal if it is treated *immediately.* According to the American Heart Association, there has been "great progress in the diagnosis and treatment of heart diseases in recent years. Today thousands live after heart attacks that would have been fatal twenty years ago. Heart diseases are no longer death sentences. They are not even necessarily crippling."

Activity 6 Core Page 26

Make arrangements to obtain and keep a small number of goldfish, guppies, or minnows. (If you wish to substitute a frog for the fish, see "Activity 6 Alternative," p. TM 6.) Living specimens are available from commercial supply houses and, in some areas, can be obtained locally. Supply houses usually furnish directions for maintenance of the specimens. *A Sourcebook for the Biological Sciences* (see References) also provides directions for the proper care of living things in the classroom.

Activity 6 Alternative

If you wish to use a frog instead of a fish in this activity, each student unit will need the following:

frog (live)
cloth or paper towel
small softwood board with a small hole
(less than 1 cm) drilled in one end
string
several dissecting or common pins
medicine dropper
beaker of water
microscope

Wrap the frog's body in wet cloth or paper toweling. Position the frog on the board so that the head faces away from the end with the hole. The frog may be placed on either its dorsal or ventral side. Use string to fasten the frog firmly to the board, leaving one hind leg free. Stretch that leg out on the board and hold it down by crossed pins. The thin web of the foot can then be spread across the hole in the board and held in place with two or three pins. This does not harm the frog.

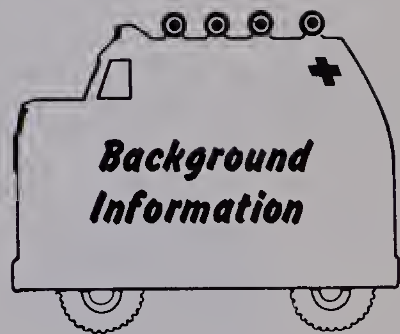
With the setup complete, use a dropper to wet the web of the foot with water every two or three minutes. If the web is allowed to dry out, the frog's circulation will be harmed. See the illustration above showing the setup.

Activity 18 Excursion Page 68

You should check out state, local, and school regulations with regard to the taking of blood samples in the classroom. A parental consent note may be all that is necessary. If so, prepare "permission slips" for students to take home to parents. Give these out while students are still working in the core so that they will be on record by the time the activity comes up.

If regulations do prohibit students from taking blood samples, the students should be advised to simply read the activity and/or choose another excursion.

The Framingham Heart Study



Most of the data appearing in *Activity 2: Are You Risking A Heart Attack?* are derived from The Framingham Heart Study, a long-term investigation of cardiovascular disease. The study was begun in 1948 by the United States Public Health Service for the purpose of determining the factors influencing the development of heart disease. The investigation is still underway.

In 1948 very little was known about the incidence, distribution, and control of heart disease. It was decided that a study should be set up in a single area, with a random sampling of 6,000 persons in the age range of 30 to 59 years. The group would be observed for a period up to twenty years.

The town of Framingham was selected as the area for the study. Framingham lies twenty-one miles west of Boston, Massachusetts, and is an industrial and trading center with 28,000 population. As is true of many New England towns, it includes not only the business and residential areas but also the outlying rural areas.

In the beginning the study became a cooperative project of the United States Public Health Service, the Massachusetts State Department of Health, and the Department of Preventive Medicine at the Harvard Medical School. In 1949 the study was included in the activities of the National Heart Institute.

The design of the study was stated formally as follows:

> . . . to measure certain selected constitutional factors and certain of the conditioning factors in a large number of "normal" persons selected at random, and to record the time during which these selected factors act and interact before clinical cardiovascular disease results.

Operations began in a clinic located at Framingham Union Hospital. The original sample consisted of 5,209 persons. The study

design required that persons be called back for re-examination at two-year intervals. Each person was assigned an anniversary date. Every two years after his or her anniversary date, the person was due for the next examination.

The Framingham Study has extended beyond the projected twenty-year period. In 1971 Boston University Medical School entered the project and the study is still in progress.

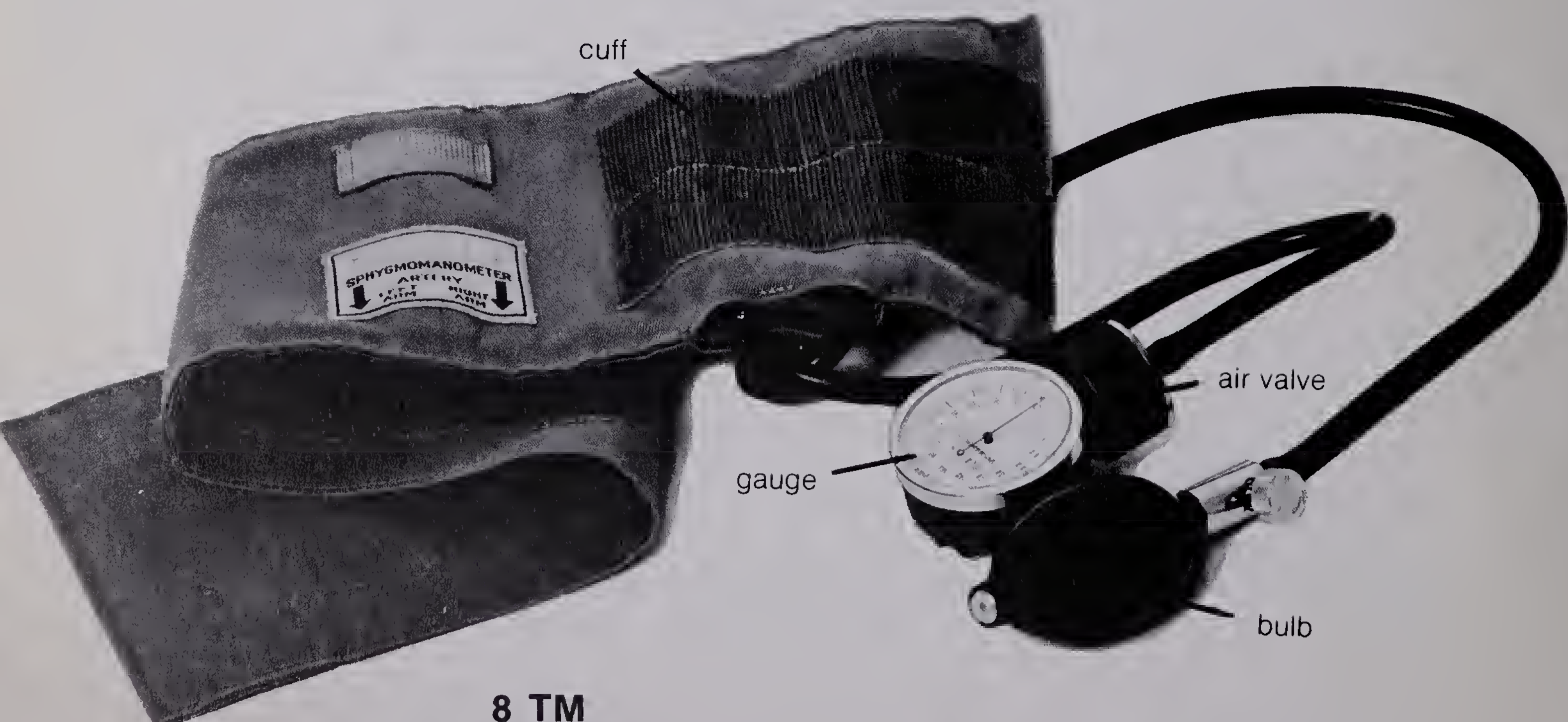
The chief source of information for the study has been the clinical examination. Directors of the study feel that it is the only basis on which repeated observations of personal characteristics can be made.

The Framingham Heart Study has been reported at various stages in numerous papers and journal articles.

Sphygmomanometer

It is probably wise not to place too much emphasis on the sphygmomanometer readings obtained by the students. Sphygmomanometers are subject to measurement error. Sometimes the indicator does not return to zero, in which case the pressure reading will be off by the same amount. Sometimes the instrument's calibration is not entirely accurate. And, of course, the instrument is subject to damage in the hands of students.

If you feel concerned about a result, first have the student check the accuracy of the instrument's indicator and calibration against a second instrument. Then have the student double-check his or her measurement. If you are then still concerned, recommend a visit to the school nurse or a doctor for verification.



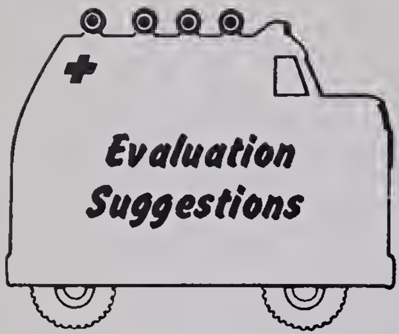
Pulse Rate

Pulse rate is discussed only generally in the student booklet because more detail would cause unnecessary confusion at this level. The pulse felt in the arteries is actually not due to the passage of blood; rather, it is the result of a pressure change in the arterial system due to the beat of the heart. This change in pressure is transmitted as a wave via the blood column and the arterial wall out to the extremities.

The blood itself flows at the modest velocity of about one-half metre per second in the aorta, but the pressure wave travels ten to fifteen times faster than that. And though the speed of the blood changes with the diameter of the vessels, the speed of the pulse wave is practically constant throughout the arterial system. Therefore, the detection of the pulse in the arm should be almost coincidental with the release of the blood into the aorta from the heart.

In selecting the activity above — taking pulse rate after exercising — the teacher should be aware of any student's medical record that might preclude such exercising.

The detectable pulse should be relatively the same in each arm. There are body conditions, however, that can change this picture. Due to abnormalities in the circulatory system, it is possible for the detectable pulse rate to differ significantly in the two arms. Obstructions in the arterial system to one arm can cause missed, or "dropped," beats, causing a lower count in that arm. For the same reason, it is possible for an arm's pulse rate to differ from the heartbeat rate.



In addition to the test, you may want to use the following essay questions and laboratory performance ideas.

Essay Questions

Three essay suggestions are included here with model answers. All three questions relate to material found in the core activities.

1. List the immediate actions you should take to save the life of a person having a heart attack or a stroke.

Answer: The actions to take are identical for heart attack and stroke. Place the victim in a comfortable position. Call an emergency service (ambulance, police, or fire department). Get the victim to the hospital emergency room at once. Don't leave the decision to act up to the patient.

2. List the factors that relate to heart attacks and strokes and describe how these factors can increase your risk of having a heart attack or stroke.

Answer: There are seven factors: heredity, high blood pressure, improper eating habits, diabetes, lack of exercise, cigarette smoking, stress. See Figure 2–9 on page 12 in the student booklet.

3. Describe the cause of a heart attack and how a heart attack affects the heart.

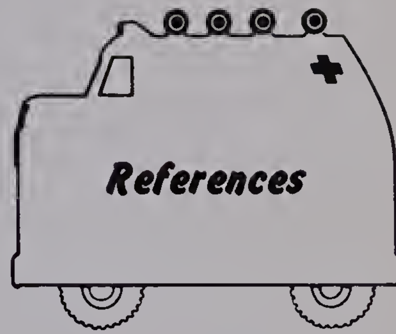
Answer: A heart attack occurs when blood supplying a part of the heart is blocked. This blockage results in the death of heart muscle cells, which impairs the heart's ability to function.

Laboratory Performance

The following items require individual students to demonstrate a skill. You may wish to assess students soon after they have learned the skill. If you wait until the students have finished the minicourse, you may have problems coordinating performance checks.

1. In this test item, you will show how to measure blood pressure. Hook up the apparatus to yourself and show how you would
   a. measure your systolic pressure.
   b. measure your diastolic pressure.
   c. record the blood pressure figures.

2. In this test item, you will show the proper way to take someone's pulse. Take a reading for 15 seconds, then figure out the pulse rate in beats per minute.



American Heart Association. 1975. *Heart facts 1975.* New York.
This public service booklet deals with up-to-date information on major cardiovascular diseases, statistics on prevalence and mortality, risk factors, heart research, and the prevention of heart attack and stroke. Good supplementary reading for both advanced and beginning students.

The American Heart Association publishes other informational pamphlets that are available at no cost. The following are suggested publications:

Body language: how your body warns you of an impending stroke.
Coronary risk handbook.
Eat well but eat wisely: to reduce your risk of heart attack.
Facts about congestive heart failure.
Facts about strokes.
Heart attack.
Heart attack: how to reduce your risk.
How fit are you?
Innocent heart murmurs in children.
Save food dollars and help your heart.
The heart and blood vessels.
You, your child and rheumatic fever.
You and your heart.
Your blood pressure.
Your heart has nine lives.

BSCS. 1973. *Biological science, an inquiry into life.* 3rd ed. Chapter 11, pp. 222–239. New York: Harcourt Brace Jovanovich, Inc.
Chapter 11 contains a systematic discussion of the heart and circulatory system, including blood and the lymphatic system. Appropriate both for teacher reference and reading material for advanced student.

Dubos, Rene, and Pines, Maya. 1965. *Health and disease.* Life Science Library. New York: Time, Inc.
Contains a short pictorial essay on atherosclerosis suitable as student reference material.

Lee, Russel, and Eimerl, Sarel. 1967. *The physician.* Life Science Library. New York: Time, Inc.

Contains two relevant pictorial essays: one on listening to the heart and taking blood pressure readings, and a longer one on restarting a stopped heart. Both are suitable as supplementary student reference material.

Morholt, Evelyn; Brandwein, Paul F.; and Joseph, Alexander. 1966. *A sourcebook for the biological sciences.* New York: Harcourt, Brace and World, Inc.

A collection of procedures, activities, and instructional management techniques suitable as a teacher reference for use with biologically oriented course materials. This book is also suitable as a source for background information.

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FOREWORD

Evidence has been mounting that something is missing from secondary science teaching. More and more, students are rejecting science courses and turning to subjects that they consider to be more practical or significant. Numerous high school science teachers have concluded that what they are now teaching is appropriate for only a limited number of their students.

As their concern has mounted, many science teachers have tried to find instructional materials that encompass more appropriate content and that allow them to work individually with students who have different needs and talents. For the most part, this search has been frustrating because presently such materials are difficult, if not impossible, to find.

The Individualized Science Instructional System (ISIS) project was organized to produce an alternative for those teachers who are dissatisfied with current secondary science textbooks. Consequently, the content of the ISIS materials is unconventional as is the individualized teaching method that is built into them. In contrast with many current science texts which aim to "cover science," ISIS has tried to be selective and to limit our coverage to the topics that we judge will be most useful to today's students.

Obviously the needs and problems of individual schools and students vary widely. To accommodate the differences, ISIS decided against producing tightly structured, pre-sequenced textbooks. Instead, we are generating short, self-contained modules that cover a wide range of topics. The modules can be clustered into many types of courses, and we hope that teachers and administrators will utilize this flexibility to tailor-make curricula that are responsive to local needs and conditions.

ISIS is a cooperative effort involving many individuals and agencies. More than 75 scientists and educators have helped to generate the materials, and hundreds of teachers and thousands of students have been involved in the project's nationwide testing program. All of the ISIS endeavors have been supported by generous grants from the National Science Foundation. We hope that ISIS users will conclude that these large investments of time, money, and effort have been worthwhile.

Ernest Burkman
ISIS Project
Tallahassee, Florida

CONTENTS

What's It All About?

Heart attack plays no favorites. It strikes the young as well as the old. It strikes women as well as men. It strikes workers as well as executives. It even strikes babies and young children.

What's more — heart attack is the Number 1 killer in the United States today. It beats murder and suicide as a cause of death. It beats cancer and diabetes. It beats automobile accidents. It beats pneumonia and the flu.

If things continue as they are, half the people in your class will one day suffer from a heart attack or stroke.

How can we get rid of this killer? This minicourse will help you see what *you* can do.

core

Activity 1 Planning

Activity 2 Page 6

Objective 1: Name factors that may increase one's risk of having a heart attack.

Sample Question: Which two factors increase the chance of heart attack?

a. regular exercise
b. high blood pressure
c. occasional pipe smoking
d. regular cigarette smoking
e. low blood pressure
f. low cholesterol level

Activity 3 Page 13

Objective 2: Describe the functions of the red blood cells, white blood cells, plasma, and platelets.

Sample Question: Match each blood part in List A with its most closely related function in List B.

List A
a. plasma
b. platelets
c. red blood cells
d. white blood cells

List B
1. keep body warm
2. help blood to clot
3. carry oxygen
4. carry nutrients
5. fight infection

Activity 4 Page 20

Objective 3: Describe what happens in the body during a heart attack and a stroke.

Sample Question: Match each condition in List A with the description in List B of what happens inside someone who has the condition.

List A
a. heart attack
b. stroke

List B
1. blood supply to heart increases
2. lack of blood kills heart cells
3. lack of blood kills brain cells
4. blood supply to brain increases

Activity 5 Page 23

Objective 4: Describe the emergency treatment and medical care for victims of heart attack.
Sample Question: Which phase of treatment following a heart attack takes 24 to 72 hours?
a. counter shock
b. intensive care
c. convalescence

Activity 6 Page 26

Objective 5: Describe the structure and function of capillaries.
Sample Question: What do capillaries do?
a. carry blood from the heart to the arteries
b. carry blood only within the heart
c. carry blood to and from all body cells

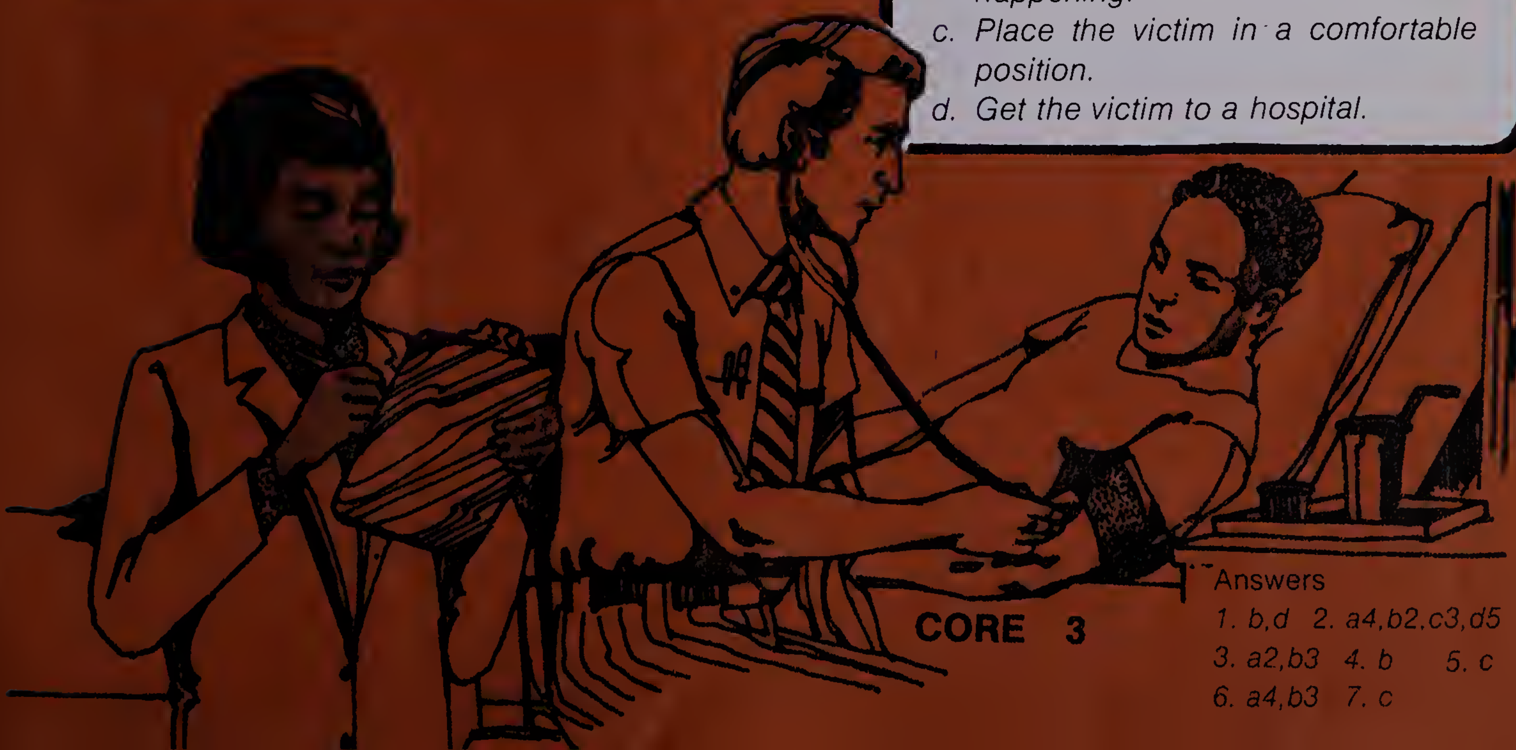
Activity 7 Page 30

Objective 6: Name the symptoms of a heart attack or stroke.
Sample Question: Match the disease in List A with its symptoms in List B.

List A
a. heart attack
b. stroke

List B
1. blurred vision, intense chest pain, numbness of face
2. dizziness, shortness of breath, sweating, nausea
3. blurred vision, dizziness, sudden weakness or numbness in face, arm or leg
4. intense chest pain, shoulder pain, shortness of breath

Objective 7: Describe the first aid you should apply to someone having a heart attack or stroke.
Sample Question: What is the first action you should take for a person who may be having a heart attack?
a. Call the doctor or emergency team and describe the symptoms.
b. Don't let the victim ignore what is happening.
c. Place the victim in a comfortable position.
d. Get the victim to a hospital.



Answers
1. b,d 2. a4,b2,c3,d5
3. a2,b3 4. b 5. c
6. a4,b3 7. c

Activity 8 Page 33

Objective 8: Describe how to measure pulse rate.
Sample Question: True or false? When measuring pulse, the wrist is held as shown.

Objective 9: Identify the normal pulse rates for children, teenagers, and adults.
Sample Question: The pulse rate for a high school student at rest is normally between
a. 40 and 50 pulses per minute.
b. 50 and 60 pulses per minute.
c. 60 and 70 pulses per minute.
d. 70 and 80 pulses per minute.

Objective 10: Describe the structure and function of arteries and veins.
Sample Question: What do arteries do?
a. carry blood to all body parts
b. carry blood within the heart
c. carry blood to and from body cells

Activity 9 Page 38

Objective 11: Describe how blood pressure is measured.
Sample Question: When your blood pressure is taken,
a. both the systolic and diastolic pressures are measured.
b. a sphygmomanometer and stethoscope are used.
c. both "a" and "b" are correct.

Objective 12: Compare the blood pressure levels for persons of different ages.
Sample Question: Teenagers have blood pressures that are
a. usually higher than for people over 30.
b. the same as those for people over 30.
c. usually lower than for people over 30.
d. varied, while those for people over 30 do not vary.

Activity 10 Page 44

Objective 13: Describe the major symptoms of anemia, varicose veins, atherosclerosis, and systemic hypertension.

Sample Question: Match each disease in List A with its symptoms in List B.

List A
a. varicose veins
b. atherosclerosis
c. anemia

List B
1. paleness, weight loss, and weakness
2. chest pain, blood in urine, fainting
3. swollen legs, pain in knees
4. no outward symptoms short of heart attack or stroke

Objective 14: Identify the usual medical treatment for anemia, varicose veins, atherosclerosis, and hypertension.

Sample Question: Match each disease in List A with its treatment in List B.

List A
a. hypertension
b. varicose veins
c. anemia

List B
1. iron supplements
2. medication and dietary control
3. surgery, and avoid standing for long
4. only dietary control

Answers
8. true 9. d 10. a 11. c 12. c
13. a3,b4,c1 14. a2,b3,c1
15. Chamber 3

Activity 11 Page 51

Objective 15: Identify the atria, ventricles, and valves of the heart and describe their functions.

Sample Question: Look at the sketch of a heart. Which chamber pumps blood to the lungs?

Are You Risking a Heart Attack?

ACTIVITY EMPHASIS: High blood pressure, high cholesterol, and smoking are the most important risk factors associated with heart attacks. Other factors are known but seem to be less important.

MATERIALS PER STUDENT UNIT

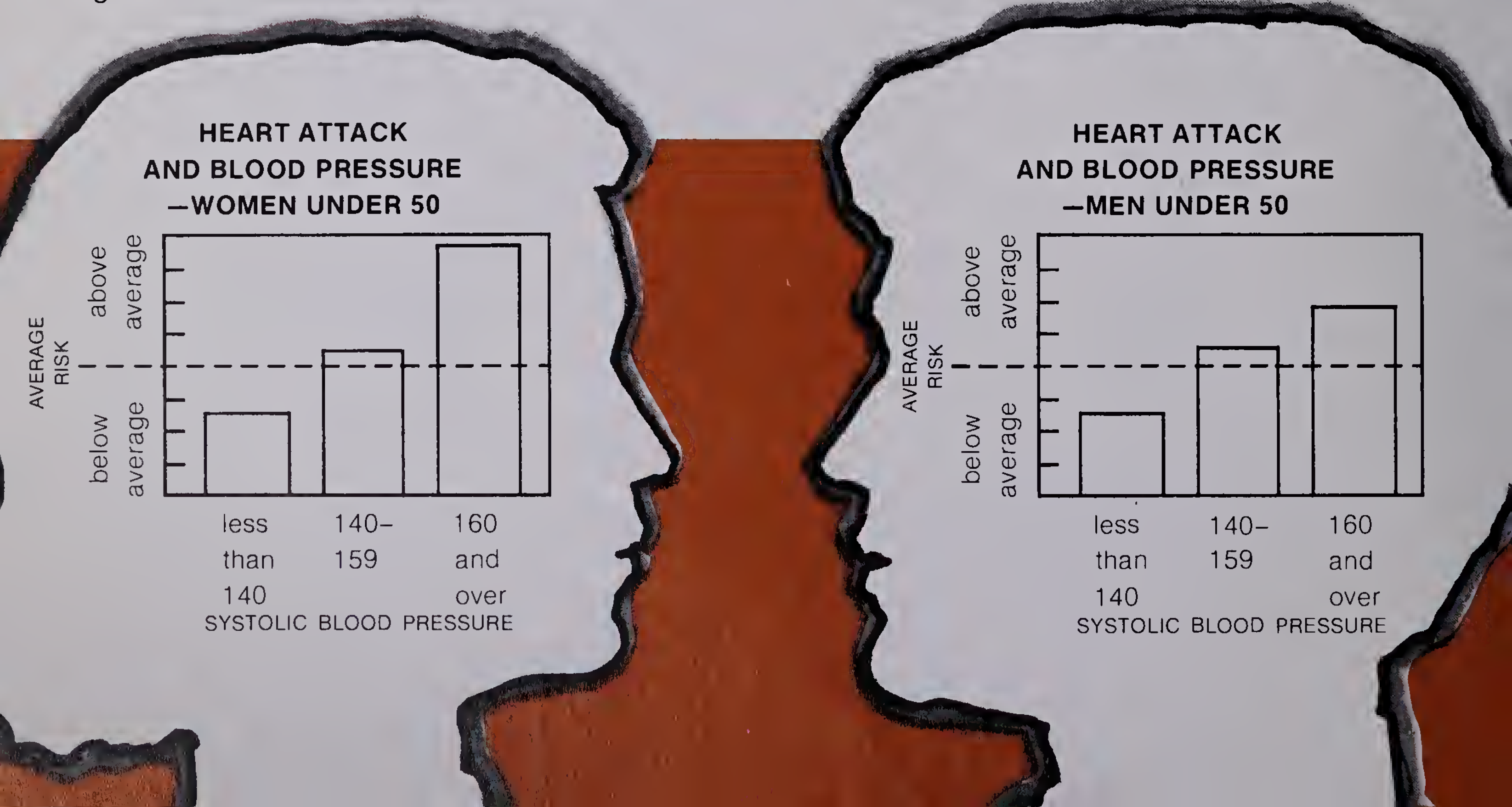
Resource Unit 2

These risk factors have been identified by a number of heart attack studies, most notably the Framingham Heart Study in Framingham, Mass., a federally funded project done in cooperation with Harvard Medical School. See page TM 7.

Why do certain people have heart attacks? Doctors and researchers are still searching for causes. But they have found that certain factors almost always go hand-in-hand with heart attack. High blood pressure, high blood cholesterol, and cigarette smoking occur again and again as the most important factors.

A person who has any of these factors runs a greater risk of having a heart attack than one who doesn't. That is why they are called "risk factors."

Figure 2–1



2-1. A woman whose blood pressure is 160 has three times the risk of heart attack. A man has more than two times the risk.

2–1. Refer to Figure 2–1. How many times greater is your risk of having a heart attack if your blood pressure is 160 rather than 135 and you're a woman under 50? If you're a man under 50?

The data in Figures 2-1, 2-4, and 2-7 were taken from the Framingham Heart Study. *Average risk* means a morbidity ratio of 1.0. For example, in Figure 2-1 a woman whose blood pressure is less than 140 has a morbidity ratio of .62. Only 62% of the expected number actually die of heart disease.

If you're having trouble reading the graph, look into *Resource Unit 2* on graphs.

Have *Resource Unit 2* available as an aid to students in reading graphs.

Every person has blood pressure. Some have "high" blood pressure, some have "low" blood pressure. Some have "normal" blood pressure. What does it all mean?

Each cell in your body needs blood to live. The heart pumps the blood to all parts of the body through "pipelines" called *arteries*. As the blood moves, it pushes against the walls of the arteries. The amount of this pushing force on each section of the arterial walls is the blood pressure.

medication

weight loss if overweight

salt reduction

Figure 2–2

How do you know if you have high blood pressure? Having a regular medical checkup is the best way to find out. If you have high blood pressure, the doctor may prescribe medicine to reduce the pressure. There are other ways to lower blood pressure, as shown in Figure 2-2.

2-2. 50% know they have high blood pressure. But only 12.5% are treating it adequately.

✓ 2–2. Many people have high blood pressure but don't know it. According to Figure 2–3, what percentage of people who have high blood pressure know about it? What percentage is treating the condition adequately?

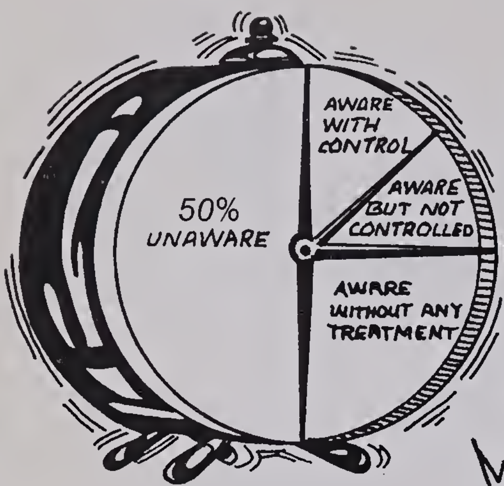


Figure 2–3

Students should be encouraged to approach family members to find out how many know they have high blood pressure and are taking adequate measures to control it.

AWARENESS OF PEOPLE WITH HIGH BLOOD PRESSURE

Remember that high blood pressure can be controlled if it is discovered early!

RISK FACTOR
HIGH BLOOD CHOLESTEROL

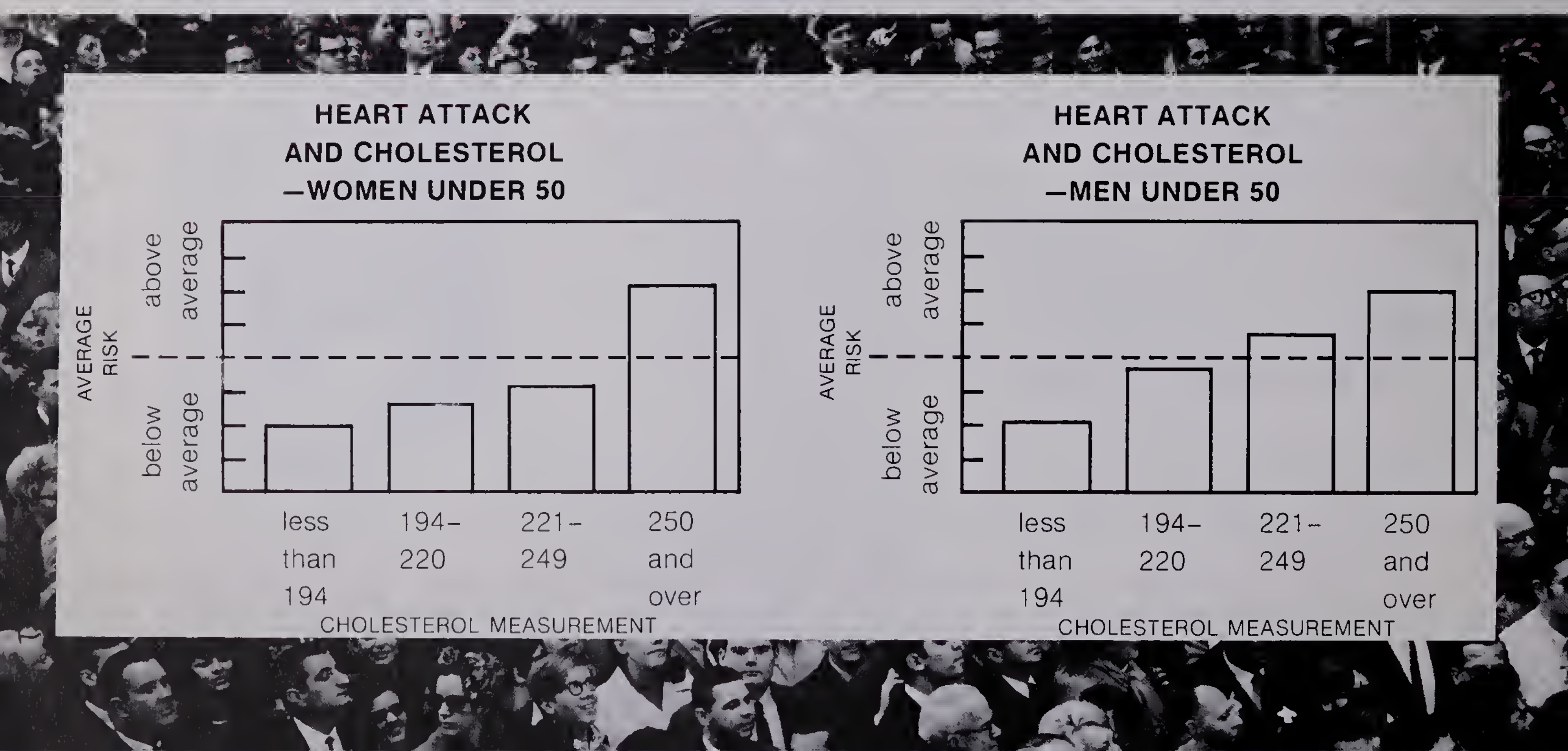
2-3. Both men and women have about three times the risk of heart attack if their cholesterol level is over 250 rather than below 194.

✓ 2–3. Refer to Figure 2–4. How much greater is your risk of heart attack if your cholesterol level is over 250 compared to under 194 and you are a man? If you are a woman?

Cholesterol level is measured in milligrams per 100 millilitres of blood.

Cholesterol is a kind of chemical found in many parts of the body, including the blood. The body manufactures cholesterol from the foods you eat. Also, some foods have cholesterol in them naturally.

Figure 2–4



Everyone needs cholesterol for good health. But *too* much in the blood is bad! It affects the inside walls of arteries, clogging them up. This means that there is less room for the blood to flow. Figure 2–5 shows what happens to a healthy artery when deposits form.

Deposits on the arteries cause them to become narrow and hardened. This condition is called atherosclerosis [ath-air-oh-sklair-OH-sis]. Most doctors believe it can be controlled by keeping the amount of cholesterol in the blood low. One way to do this is to eat foods low in cholesterol. The other is to eat foods low in saturated fat (animal fat).

Cholesterol level is measured by taking a sample of blood. The blood is then analyzed chemically.

Figure 2–5

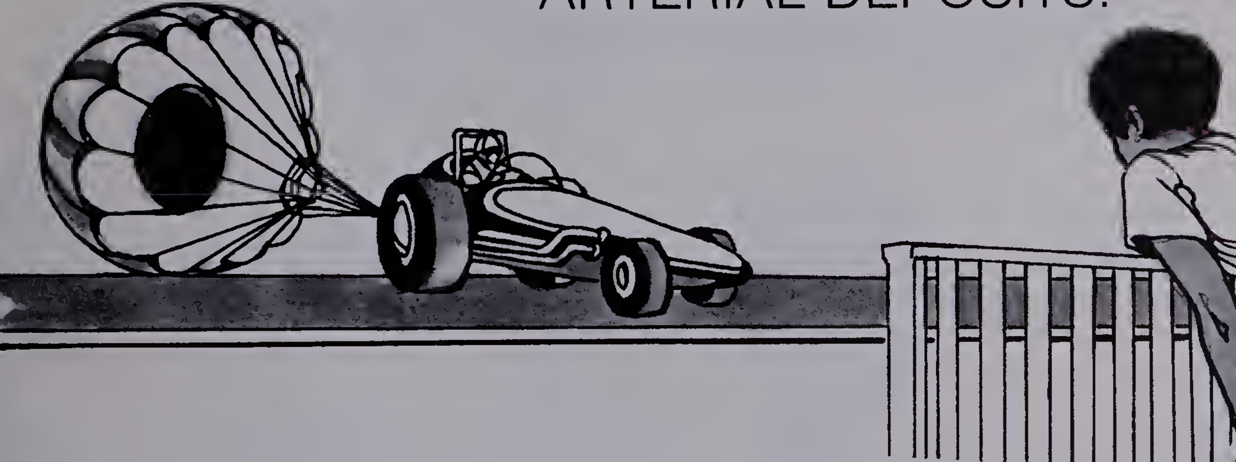
✓ 2–4. Why is it important to keep arteries open? What do you think would happen if an artery became entirely clogged up?

2-4. Arteries should be kept open to allow blood to flow to every cell in the body. If an artery became entirely clogged, no blood could flow through it.

If you said that no blood would be able to flow through the artery, you were right!

If the clogged-up artery happens to be supplying blood to the heart, a heart attack occurs. A heart attack happens when a part of the heart doesn't receive enough blood. When part of the brain doesn't receive enough blood, a stroke occurs.

HELP SLOW DOWN ARTERIAL DEPOSITS!



In all of us, fats and minerals gradually deposit on the walls of arteries. In fact, deposits on the arteries have been found in children as young as three. By age ten, the coronary arteries — those that supply the heart itself — can have similar deposits. Of the American soldiers killed in the Korean War, 8 out of 10 had deposits in the arteries. By age fifty, most Americans show some closing off of the arteries, usually without any symptoms.

Watch Your Diet	EAT	Avoid Excess
BEWARE CALORIES the energy-producing value of food. If body activities do not use energy available, calories store up in fat. **BEWARE CHOLESTEROL** used by the body to make certain chemicals. Excess cholesterol is associated with fatty deposits in artery walls.	Fish Lean poultry, lean meat Vegetables and fruit Buttermilk, cottage cheese Spaghetti, macaroni Potatoes Bread, plain rolls Polyunsaturated margarines and oils Cereals Skim milk	Pastry and bakery products Butter, ordinary margarine, cooking fats Whole milk Cream cheese Liver Kidneys Fatty meats Egg yolks -- don't eat more than 2 or 3 per week

Figure 2–6

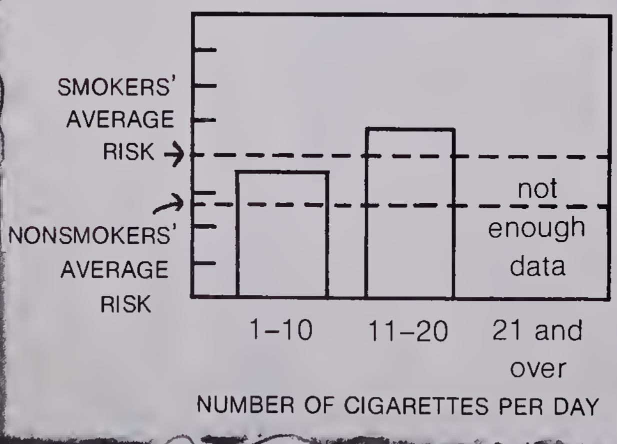
✓ 2–5. List the foods you ate yesterday. Which fall into the EAT and AVOID categories in Figure 2–6? Which do you think were low in cholesterol?

2-5. Lists will vary. Foods listed in the EAT category are lower in cholesterol than those listed in the AVOID category.

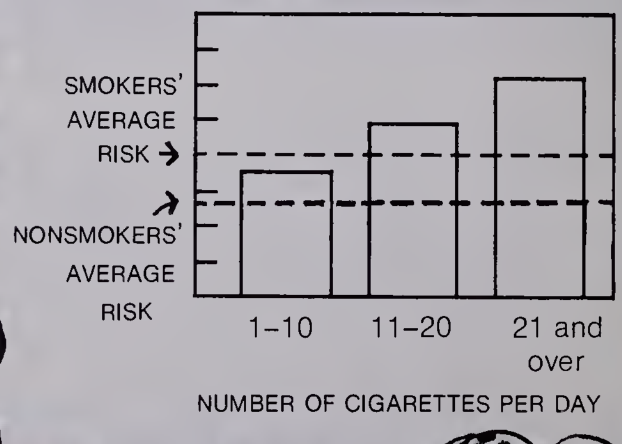
RISK FACTOR
CIGARETTE SMOKING

Figure 2–7

HEART ATTACK AND CIGARETTE SMOKING —WOMEN UNDER 50



HEART ATTACK AND CIGARETTE SMOKING —MEN UNDER 50



✔ 2–6. Look at Figure 2–7. Suppose a man smokes forty cigarettes a day. How many times greater are his chances of having a heart attack than a nonsmoker? Compare a nonsmoker's risk to that of a woman who smokes 15 cigarettes a day.

2-6. A man who smokes forty cigarettes a day has more than twice the risk of heart attack. A woman who smokes 15 cigarettes a day has about 1½ times the risk.

No one is saying yet that smoking causes heart attack. But for some reason, they go together. The data indicate that heavy smoking seriously increases the risk of heart attack.

It seems to make little difference how long a person has been smoking. If a smoker stops, his or her risk of having a heart attack goes down to that of a nonsmoker after some time.

WHAT HAPPENS IF YOU COMBINE RISK FACTORS?

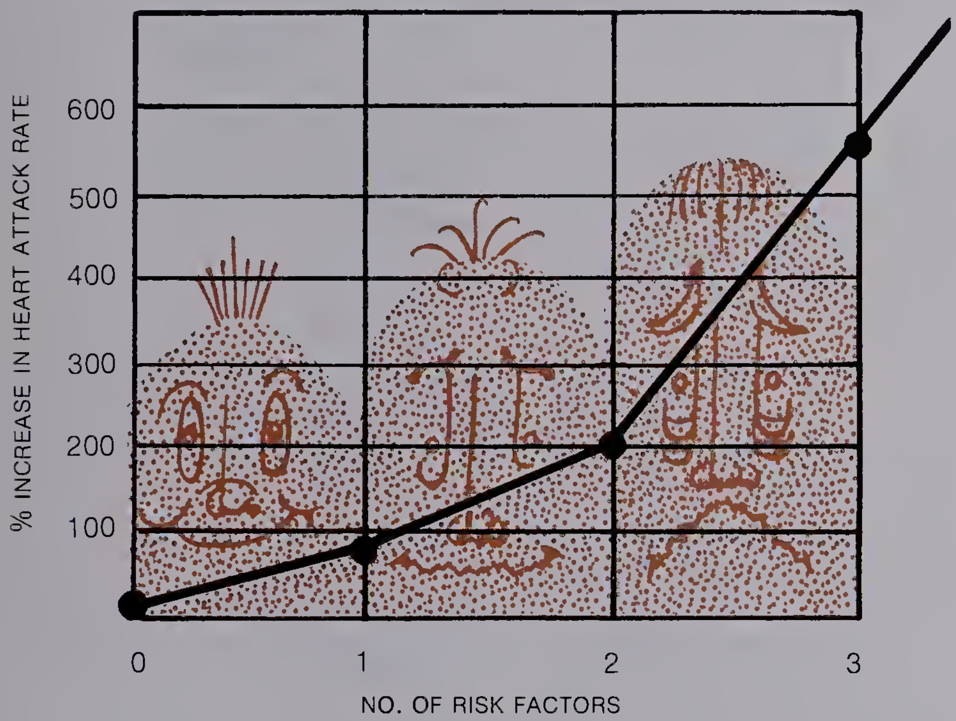


Figure 2–8

✔ 2–7. Compared to someone with no risk factors, how is your chance of having a heart attack different if you have one risk factor? Two risk factors? Three risk factors? (Study Figure 2–8.)

2-7. One risk factor increases your chance of attack by about 70%. Two risk factors increase your chance by 200%. Three risk factors increase your chance by more than 500%.

Are There Other Risk Factors?

High blood pressure, high blood cholesterol, and smoking are the most important risk factors, but there are others. Heredity, overweight, not enough exercise, diabetes, stress, and severe physical strain are other risk factors. Don't ignore them!

Figure 2–9 on the next page shows seven factors that may lead to heart attack. It suggests how much risk is related to each factor, and it shows how you can control and prevent heart disease.

FACTORS	RISK	CONTROL & PREVENTION
Heredity	Your chances increase if other members of your family have heart or circulatory disease.	No cure — your heredity cannot be changed. But you can change your health habits to reduce chances.
High blood pressure	Lack of medical control doubles chances of attacks.	No cure, but usually can be well controlled. Early detection of illness important. Have yearly checkups.
Overweight, improper eating habits, high levels of fat and cholesterol in blood	Exact role in illness is uncertain. Chance of fatal circulatory disease is five times as high in overweight people with high cholesterol or blood fats.	Less food to maintain proper weight. Less cholesterol (high in egg yolk, liver, kidney, shell fish). Less ''hard,'' saturated fats (high in dairy products, hamburger, hot dogs, luncheon meats).
Cigarette smoking	Danger: 2 packs or over per day. Pack-a-day smoker has up to two times the risk of a nonsmoker.	Don't smoke; or if you do already, ask someone for advice about a plan for quitting.
Diabetes	Unless detected early and controlled, nearly always causes heart damage and other circulatory problems.	Yearly health checkups and proper medical control.
Lack of exercise	Less active persons show more risk.	Any form of daily exercise seems to reduce chances of these illnesses.
Stress	Certain personality pattern seems prone to attack: hard-driving, excessively ambitious, pressured by deadlines.	Improved emotional balance lessens stress and tension. Balance achieved through proper rest, food, and exercise.

Figure 2–9

✓ 2–8. If a number of your relatives have had heart attacks, should you just give up and wait your turn? How can you help yourself?

✓ 2–9. Diabetes is a risk factor. Are any members of your family diabetic? If so, have you been checked for diabetes in the past year?

Except for heredity, all of the factors listed in Figure 2–9 can be brought under control if you act early. Evidence is gradually being gathered showing that such control reduces the risk of heart attack or stroke.

★ **2–10. What about you? What risk factors may increase your chance of having a heart attack?** 2-10. Every individual must analyze his or her situation with regard to possible risk factors.

✓ 2–11. Consider your own life-style. Then consider your heredity. Write a brief paragraph on how you can decrease your chances of having a heart attack or stroke.

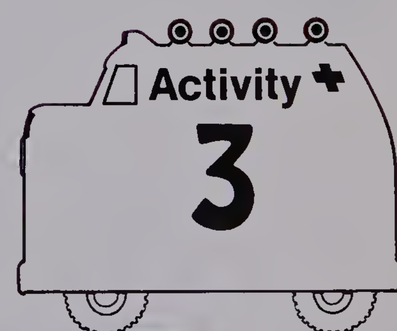
2-11. Family history and medical circumstance will determine response.

It is important to alleviate anxiety in students whose parents or grandparents have a history of heart attack. Point out that so many controllable factors are involved that heredity is by no means the crucial factor.

2-8. Never give up! Heredity is only one risk factor among many. Eliminate all other risk factors and go for regular medical checkups, and you can look forward to a long and healthy life.

2-9. Answers will vary. (Since diabetes is a risk factor, determine by medical checkup if you have the disease. If you have diabetes, follow all medical treatment to control it.)

The Vital Red Fluid



There's no getting around it — this red fluid keeps you going! It brings food and oxygen to your cells. It gets rid of wastes. If you have an infection, it fights to make you well again. You can't live without it. Yet, if you're like most people, you'd rather not see it. It's your blood!

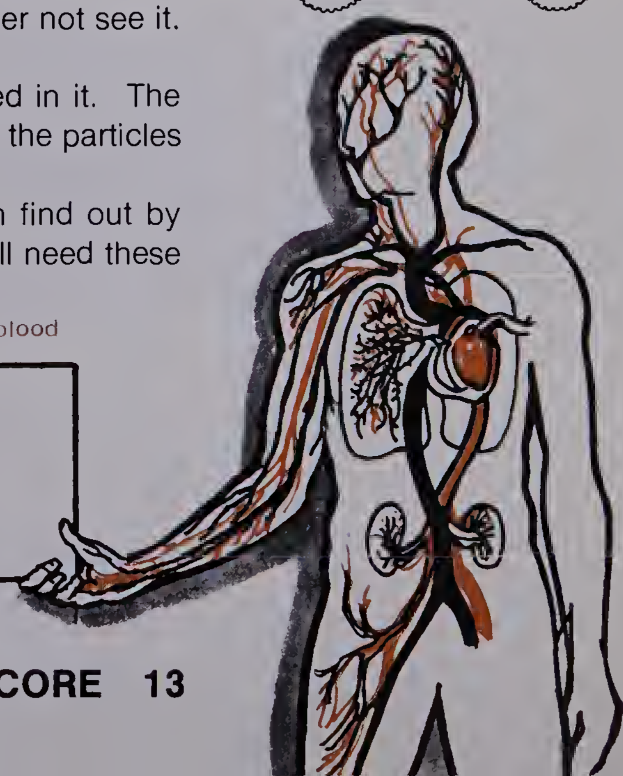
Your blood is a fluid with solid particles suspended in it. The liquid part is called the *plasma*. You'll study three of the particles that make up the solid part of the blood.

What do these solid particles look like? You can find out by examining a prepared slide of human blood. You will need these items: MATERIALS PER STUDENT UNIT

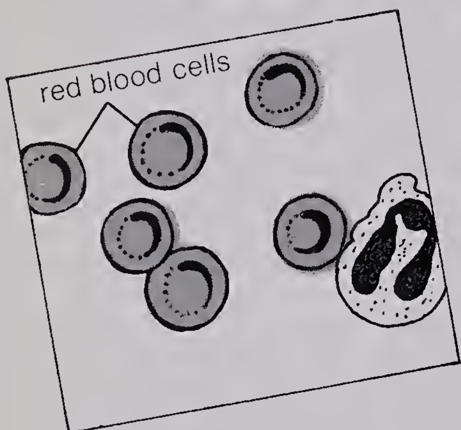
microscope, compound; slide, prepared, human whole blood

Resource Unit 3

microscope
prepared blood slide



ACTIVITY EMPHASIS: The solid components of blood are microscopic and each has a specific function. Blood cells can be counted, thereby providing information on the health of an individual.



Encourage students to draw what they see under the microscope, not what they think they are "supposed to see." Provide additional help for those having trouble with the microscope.

Be sure you know how to use the microscope correctly. If you have not done *Resource Unit 3* on microscopes, do it now.

A. Place the slide under the microscope. Focus by using low power first. Then switch directly to high power to see the blood cells.

Have *Resource Unit 3* available to aid students in use of microscopes.

✔ 3–1. In your notebook, sketch what you see on the slide.

3-1. The drawing next to Step B will help identify the red blood cells on the slide.

B. Find the cells in your slide that look like pale pink disks. These are the *red blood cells.* The drawing to the left shows how one slide looks under the microscope. Yours may look somewhat different.

✔ 3–2. Label the red blood cells on your sketch.

3-2. Students should identify the red blood cells on their sketches.

Red blood cells carry oxygen to the body. The red cells contain a substance called *hemoglobin.* As blood passes through the lungs, the hemoglobin latches onto the oxygen. The hemoglobin then releases the oxygen to the rest of the body.

RED BLOOD CELLS CARRY IMPORTANT CARGO!

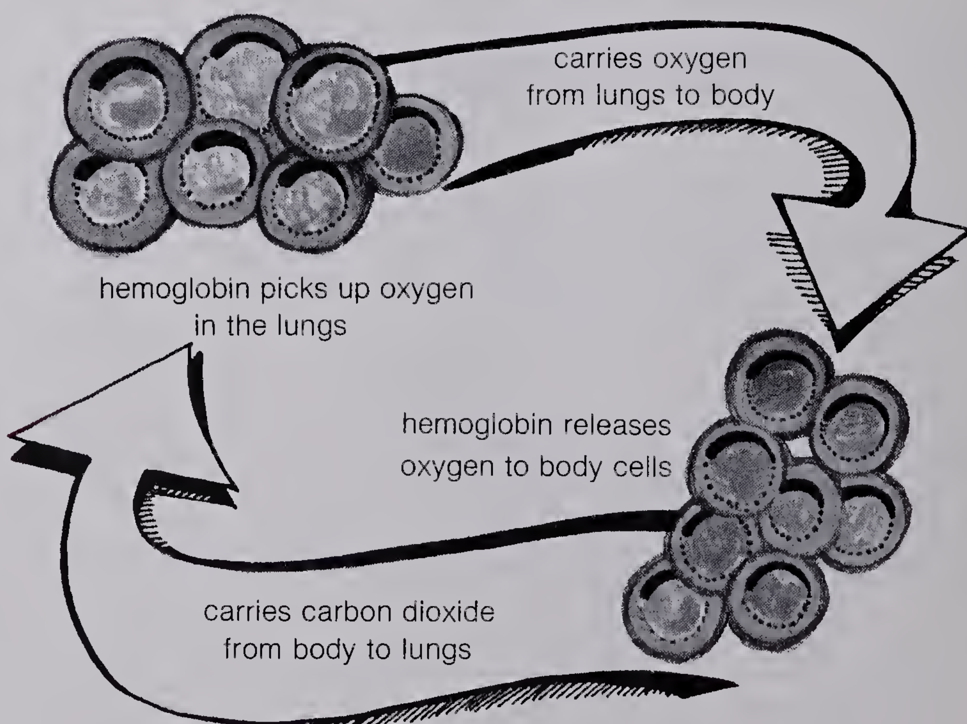
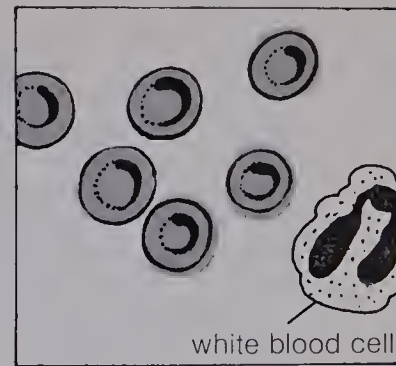


Figure 3–1

A scientific name for the red blood cell is "erythrocyte." You may have heard another name for it — "red corpuscle."

C. Look at the slide again. Look for odd-shaped cells, larger than the red blood cells. The stain used in preparing the slide may make these cells look blue with a purple center. These are the *white blood cells.*



✓ 3–3. Label the white blood cells on your sketch.

3-3. White blood cells are shown in the drawing next to Step C. These should help identify the white cells on the sketch.

The center of the white blood cell is the nucleus. The nucleus allows the cell to divide again and again.

The job of the white blood cells is to fight disease. When an area is infected, white blood cells surround the germs. The white cells then produce chemicals called *antibodies* that help destroy the germs. Sometimes the white blood cells actually take the germs into their bodies, or ingest them, as shown in Figure 3–2.

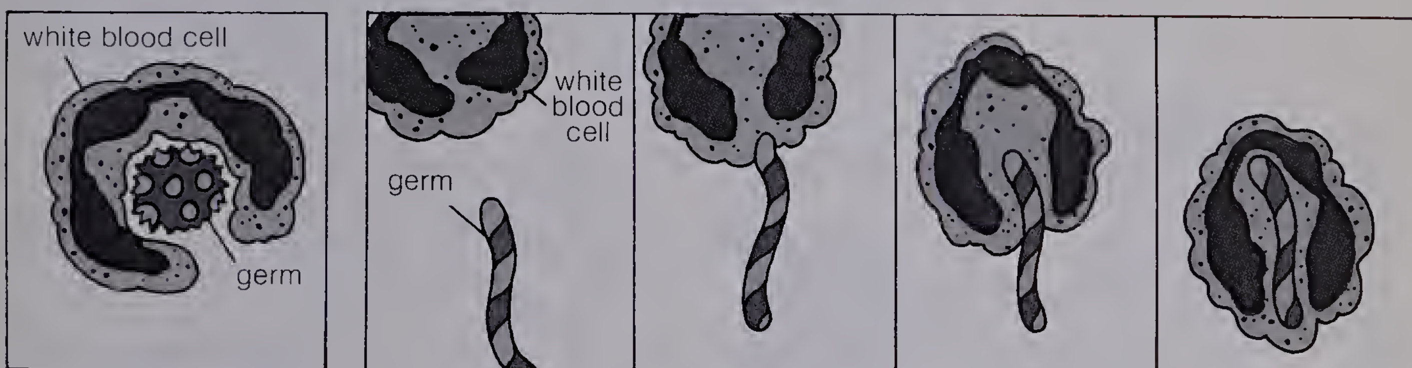


Figure 3–2

White blood cells also protect against foreign objects in the body. Notice what happens in Figure 3–3 when a splinter becomes lodged under the skin.

(a) White blood cells surround a splinter embedded in the skin.

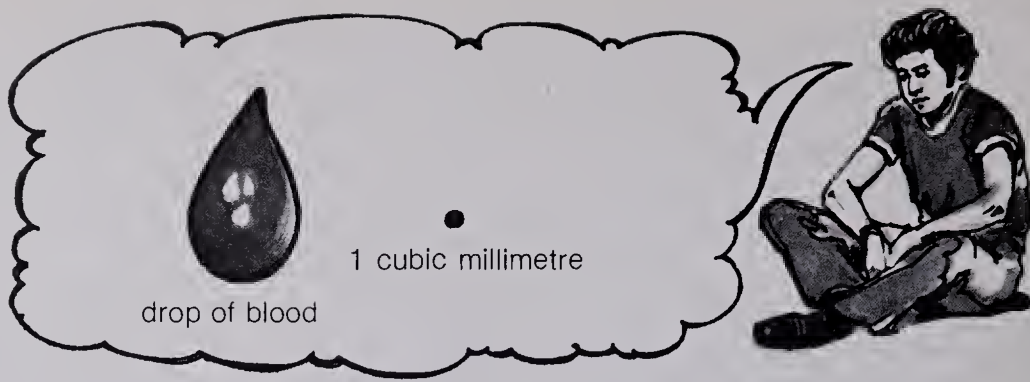
(b) The white cells ingest any bacteria in the tissue of the finger. In time, the splinter dislodges.

Figure 3–3

✓ 3–4. Are there more red blood cells or white blood cells on your slide?

3-4. There are more red blood cells.

In the body there are about 500 to 1000 times more red than white blood cells.



Think of the size of a drop of blood. Now imagine 1/25 of that drop. That is equal to about 1 cubic millimetre. In an adult, 1 cubic millimetre contains 5 to 6 million red blood cells. The same amount of blood has from 6 to 10 thousand white blood cells. However, these numbers can vary. Health and physical activity of a person make a difference. Where one lives is another factor.

Who has more red blood cells?

3-5. At high altitudes.

✔ 3–5. There is less oxygen in high altitudes than at sea level. In which place would you expect to find people with more red blood cells than average?

Counting the red and white blood cells is important in a physical checkup. If there are too many white blood cells, for example, it is usually a sign of infection in the body. The white blood cells have multiplied and rushed to the site of the infection. The doctor can tell many things about the health of the patient from the blood count.

You may have given a drop of blood from your finger during a checkup. That's more than enough for a blood count. A portion of the drop is diluted with another liquid. This thins out the red blood cells, making them easier to count. A grid is placed over the diluted sample of blood. The grid is then put under a microscope. The cells in several squares are counted and an average is taken. Figure 3–4 shows how a grid looks under the microscope.

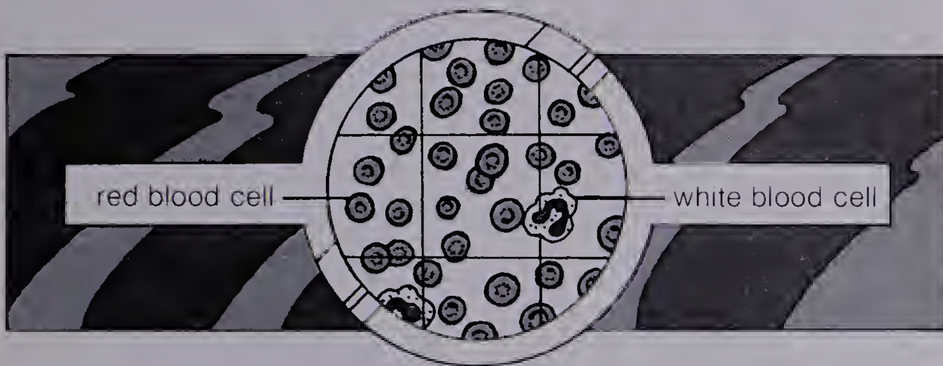


Figure 3–4

White blood cells are counted in the same way as red blood cells. However, the blood sample is diluted to a lesser extent.

✔ 3–6. What is one reason for taking a blood count during a physical exam?

3-6. An excessive number of white blood cells usually indicates the presence of an infection.

Platelets are the third kind of particles in the blood. Platelets are small, colorless particles, about a third the size of red blood cells. Chances are that you may not be able to see them on your prepared slide. Figure 3–5 gives you an idea of their shape and size. Notice that platelets come together to form chains.

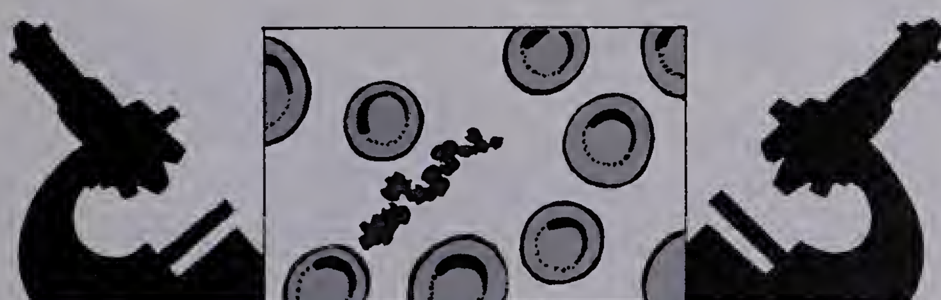


Figure 3–5

When you have a wound, platelets rush to the scene. Their function is to help the blood clot. You can see how important platelets are in injuries that cause bleeding. Without platelets the blood wouldn't stop flowing out of the injured blood vessels.

★ **3-7. What is the most important job of each solid particle in the blood?**

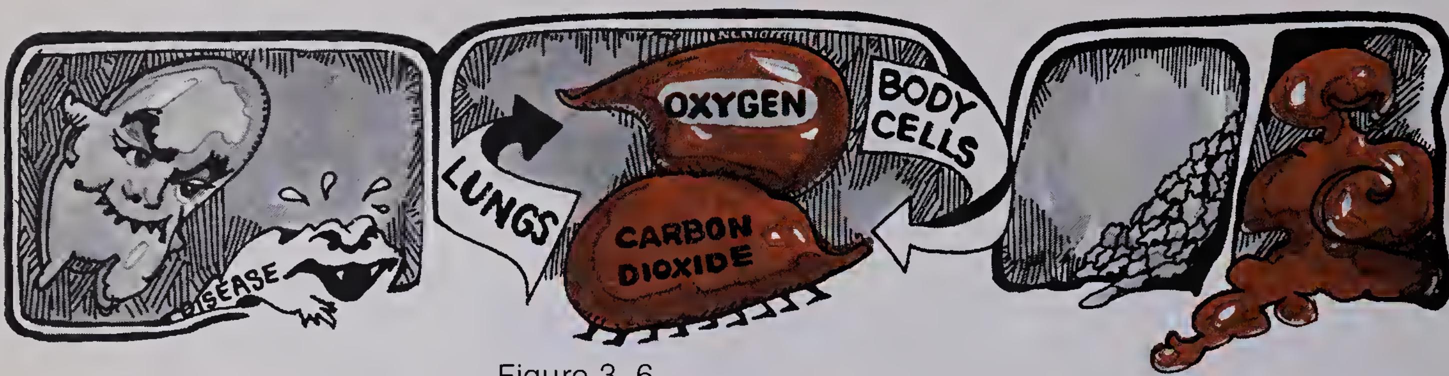


Figure 3–6

3-7. Red blood cells carry oxygen and carbon dioxide. White blood cells fight disease. Platelets cause clotting.

The liquid part of the blood — the plasma — won't show up on your slide. It is all dried up. But it is just as important as the solids it carries. All food going to the cells is carried in the plasma. Plasma also carries wastes away from the cells.

3-8. Carbon dioxide.

★ **3-8. What waste substance is taken away from body cells by the red blood cells?**

More than half the blood is plasma. When separated from the solids, it is a clear liquid, as shown in Figure 3–7. This liquid keeps your blood vessels filled. It also makes it easy for food to flow into cells and for wastes to flow out.

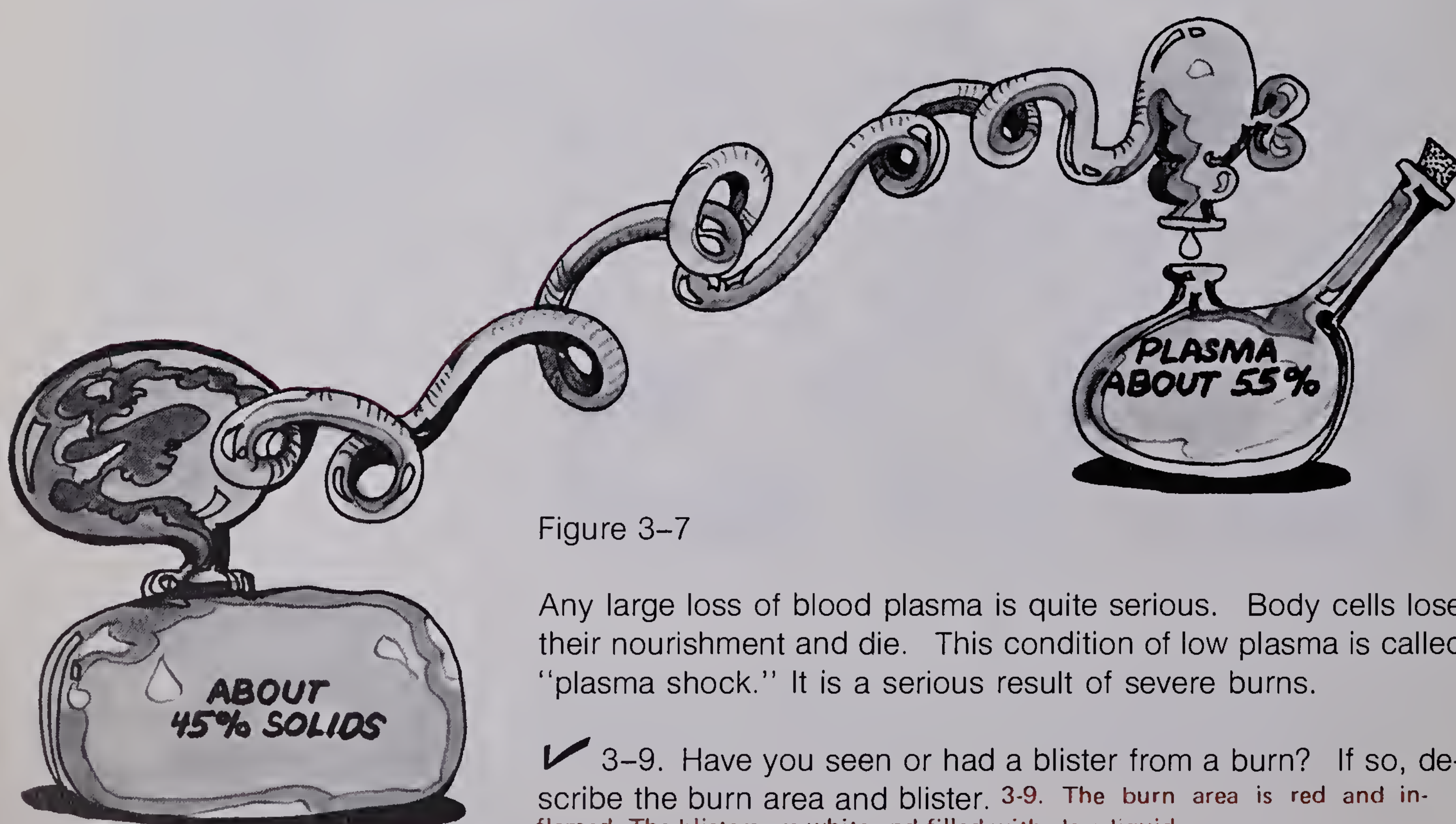


Figure 3–7

Any large loss of blood plasma is quite serious. Body cells lose their nourishment and die. This condition of low plasma is called "plasma shock." It is a serious result of severe burns.

✓ 3–9. Have you seen or had a blister from a burn? If so, describe the burn area and blister. 3-9. The burn area is red and inflamed. The blisters are white and filled with clear liquid.

Chances are you've seen the liquid that collects to form a blister. This is part of the plasma. It has leaked from the cells to the surface just under the top layer of skin cells.

✓ 3–10. Imagine a person who has had 75% of the body burned. How would this affect the amount of plasma in the blood?

3-10. The plasma volume in the blood would be severely reduced.

✓ 3–11. Why do you think plasma transfusions are given to persons who have been severely burned?

3-11. Plasma transfusions are given to replace the lost plasma. Otherwise, too many body cells lose their nourishment and die.

★ **3–12. Suppose a person suffers large losses of plasma. How does such a loss affect the functioning of the body?**

3-12. A loss of plasma means that fewer gases, foods, waste products, and other chemicals are able to be transported to vital organs throughout the body. Many body cells will die.

Blood does a lot of different jobs in the body. Figure 3–8 shows the most important. Can you add others?

Figure 3–8

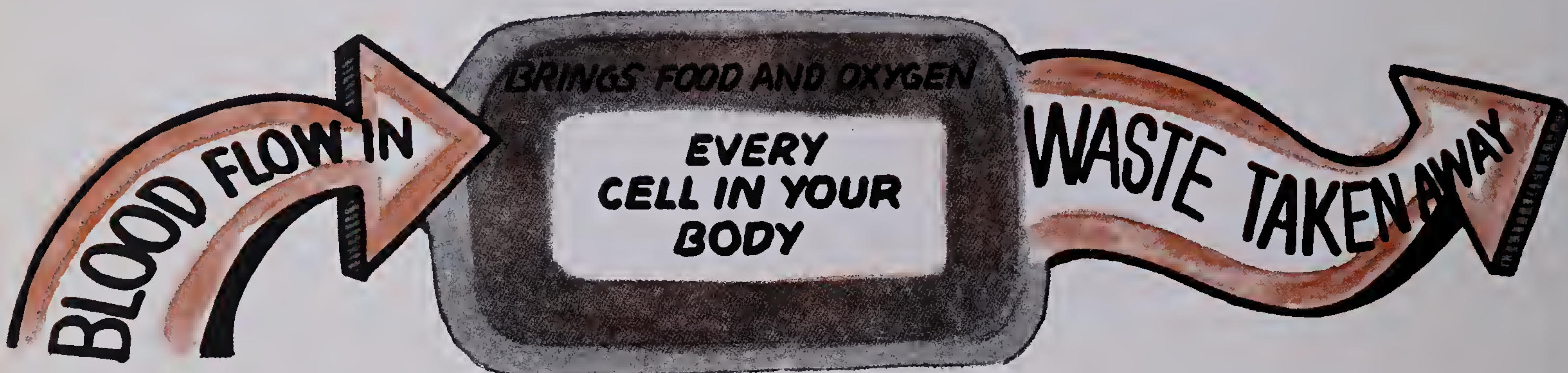
Activity 4

What Causes Heart Attacks and Strokes?

MATERIALS PER STUDENT UNIT

None.

To stay alive, every cell in your body must be in contact with a flowing liquid. The liquid must be rich in food and oxygen. The liquid must flow in order to take away the cell's waste materials.



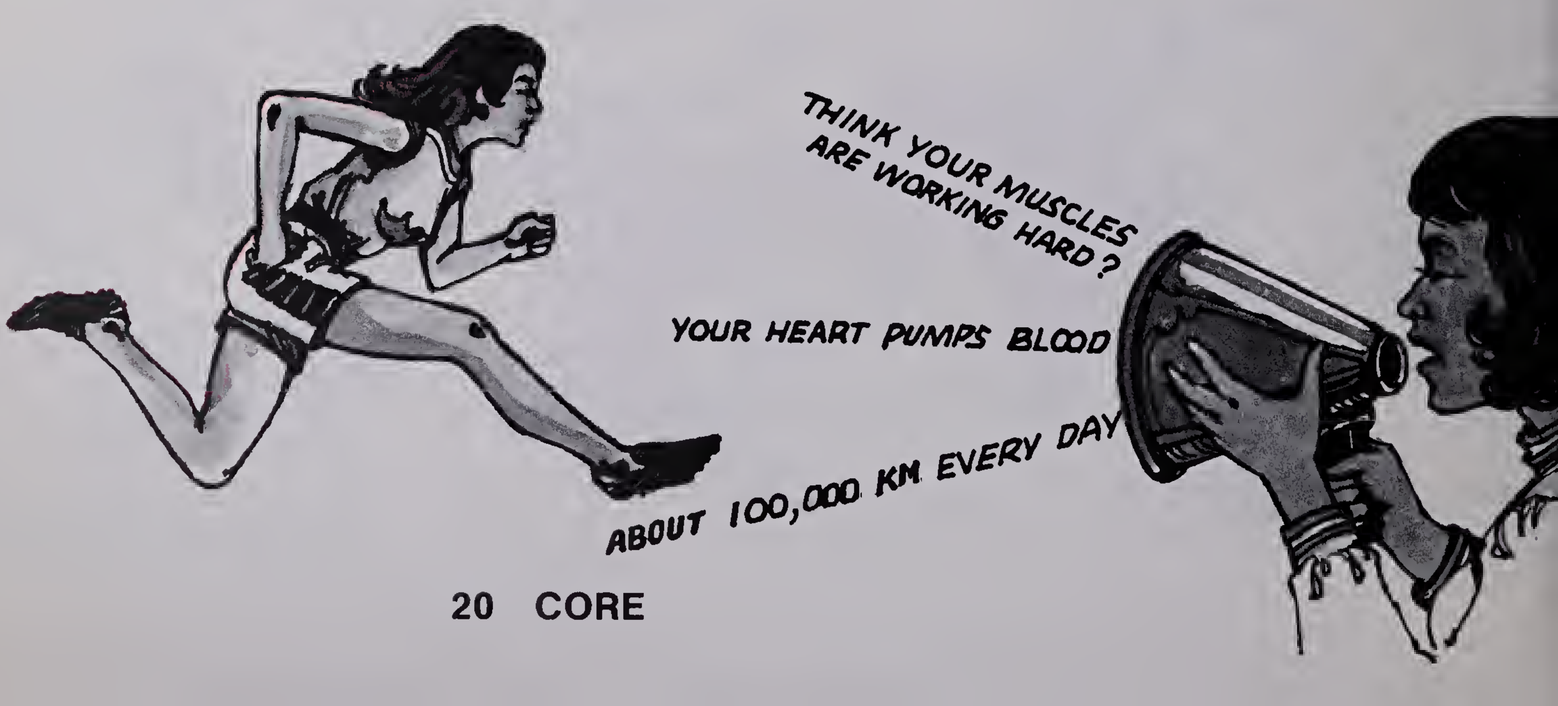
ACTIVITY EMPHASIS: Cell death in heart muscle tissue is a heart attack. Cell death in brain tissue is a stroke. In both cases, cell death usually results from a stoppage of the blood supply to the organ.

Blood is the flowing liquid that supplies your body cells. Each cell in your body must have a continuous supply to keep on living. Cut off that supply, and the cell dies!

✓ 4–1. How does blood get to your body cells?

4-1. Through blood vessels.

What does blood supply have to do with heart attack? To understand this connection you must know something about the heart. Your heart is a muscle of thousands of muscle cells. It is a very hard-working muscle. Every day it pumps blood through about 100,000 kilometres of blood vessels.



Like all your body cells, the muscle cells of your heart need a continuous supply of blood.

Strangely, the muscle cells in the heart do not get their supply of blood from the blood that passes through the chambers of the heart. Instead, they are supplied by two arteries, called *coronary arteries.* These arteries look very much like branches of a tree, as shown in Figure 4–1. The coronary arteries branch again and again into smaller and smaller tubes, carrying blood to each cell in the heart.

Point out that a single-celled animal such as an amoeba has an advantage over a many-celled animal. The one-celled animal is in direct contact with the outside world. Its wastes can flow out directly. The oxygen and food it needs can flow into it directly. A many-celled animal, such as a human, needs blood to bring in the "good stuff" and cast out the "bad."

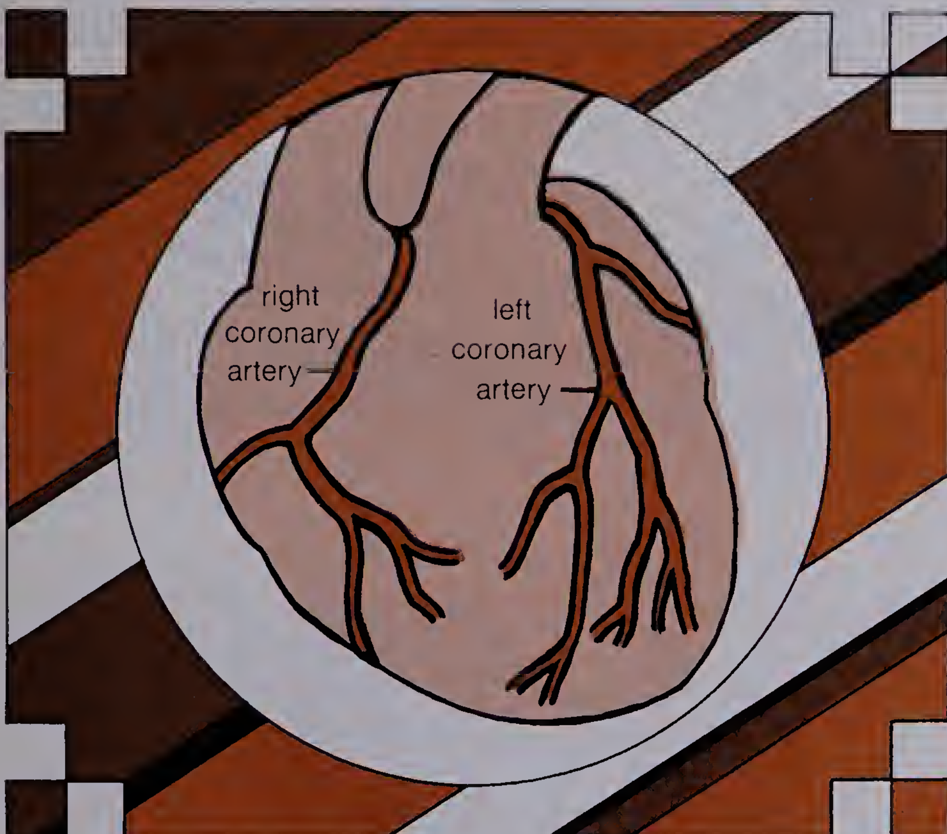


Figure 4–1

★ **4–2. Suppose one of the coronary arteries became blocked. What would happen to the muscle cells supplied by that artery?**

4-2. The muscle cells would die.

✔ 4–3. How would this affect the heart's ability to pump?

4-3. The heart would not be able to pump as well. It might even stop.

If you've ever visited anyone in a hospital, you may have heard the terms *cardiac* and *coronary*. The word *cardiac* refers to the heart. Therefore, a patient who has had a heart attack is a cardiac patient. *Coronary* refers to the coronary arteries. When the term is used in connection with a heart attack, it means that there is a stoppage of blood flow in one or both coronary arteries.

A common cause of stoppage is the formation of a blood clot in the coronary artery. (See Figure 4–2A.) Or a coronary wall may break, causing a hemorrhage, or bleeding. (See Figure 4–2B.)

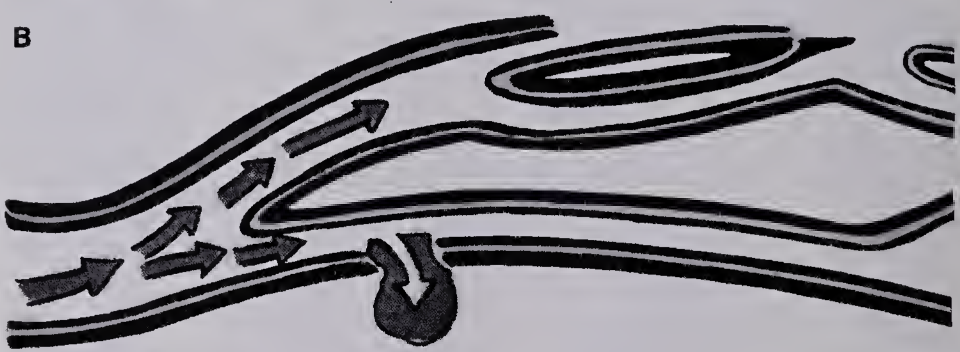


Figure 4–2

4-4. "Myocardial infarction" refers to cell death within the heart due to blockage of blood flow to the heart muscle cells.

When one or both of the coronary arteries are blocked, the muscle cells that are cut off from the blood supply die. Cell death in the heart muscle is a *heart attack*. How serious the attack is depends on how much damage there is to the cells.

Angina pectoris is a condition in which the heart muscle gets less blood supply than it needs. It is caused by the narrowing of a blood vessel and is usually temporary. There is often pain in the chest and left arm.

✔ 4–4. *Myocardial infarction* is the term often used to describe a coronary heart attack. Use the following clues to explain the meaning of this term.

Myocardial: refers to the muscle cells within the heart wall
Infarction: an area of dead cells

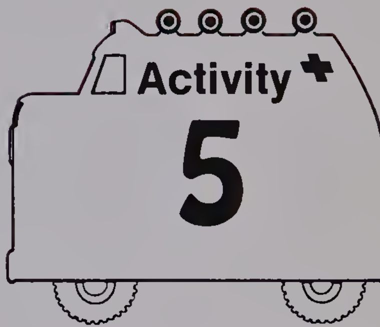
Like all cells in your body, brain cells must also have a continuous supply of blood. When the supply of blood is cut off, the brain cells die. Brain-cell death is called a *stroke*. A clot may block one of the arteries in the brain, cutting off the flow of blood. Hemorrhage, or bleeding, of an artery in the brain can also cut off the blood supply.

★ **4-5. How is a stroke like a heart attack?**

4-5. Both heart attack and stroke involve a blockage of blood flow and resultant cell death.

The principle is the same. If blood doesn't get to the cells, they die. You can see how important good blood flow is. Heart muscle and brain cells are essential to life. Keeping blood vessels in good shape is the best way to avoid both heart attack and stroke.

Heart Attack—Care and Treatment



ACTIVITY EMPHASIS: First aid is concentrated on making sure that the heart does not stop beating. Subsequent treatment involves intensive care and convalescence.

Immediate medical attention is absolutely essential to survive a heart attack. Many people get into the act. Ambulance teams, hospital technicians, nurses, doctors — they all play a role. This activity points out some important parts of the care and treatment of a heart attack victim.

MATERIALS PER STUDENT UNIT
- cassette tape for *Heart Attack*
- cassette player, preferably with headphones

A tape cassette goes with this activity. It consists of an interview with a doctor. The doctor answers questions about what happens in the ambulance, at the hospital, and after the patient is released to go home.

Illustrations that follow show some of the activities discussed on the tape. Answers to the following questions can be found by carefully listening to the tape.

5.1. Make sure that the heart does not stop.

★ **5-1. Emergency teams who give aid to a heart attack victim try to make sure that one thing does not happen. What is that one thing?**

5-2. The emergency team must first decide if the patient has had a heart attack.

✓ 5-2. Name the first decision the emergency team makes when the team reaches the suspected heart attack victim.

5-3. (1) Monitor the heartbeat; (2) give intravenous medication; (3) administer oxygen; (4) administer counter shock or other medication.

✓ 5-3. What other actions may be taken by the ambulance team on the way to the hospital?

5-4. Administer medication or counter shock.

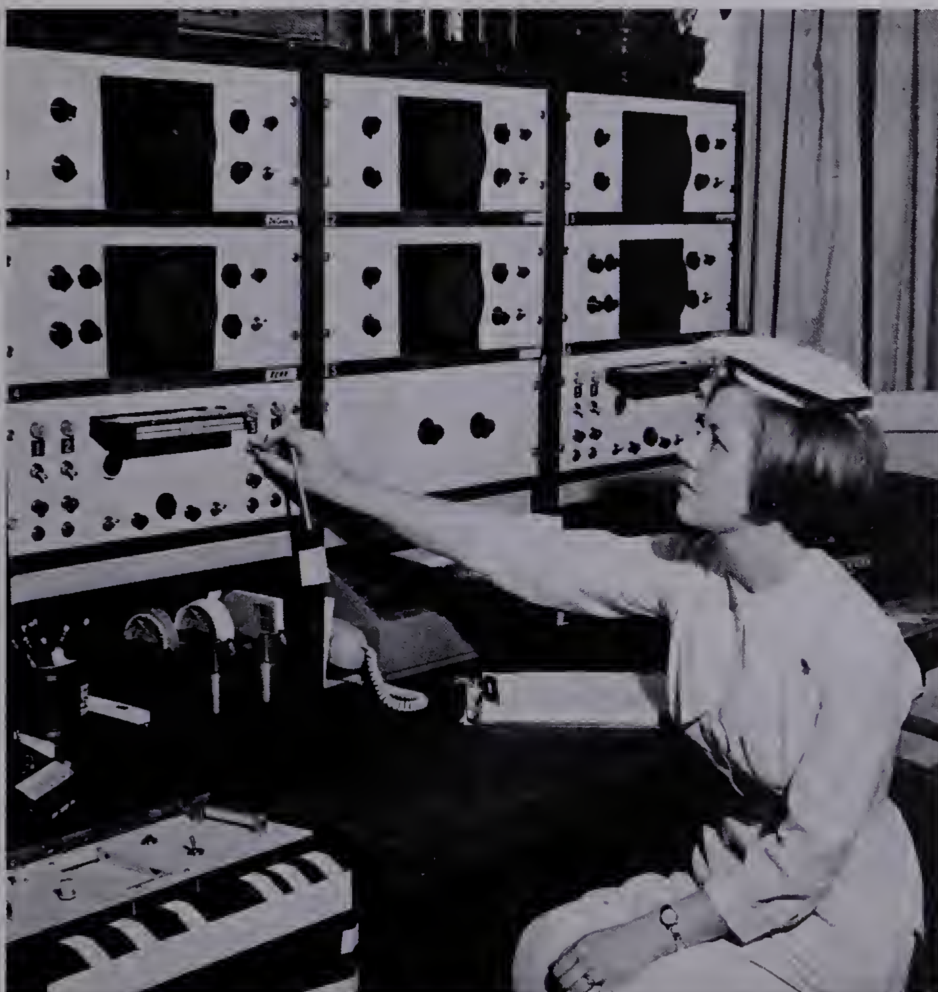
✓ 5-4. Suppose a heart attack victim's heart stops on the way to the hospital. What would the emergency team do? (Assume the ambulance has modern equipment.)

✓ 5-5. Does mouth-to-mouth resuscitation start a heart that has stopped beating? 5-5. No.

★ **5–6. How long does the heart attack patient stay in the intensive care unit? What is the purpose of keeping the patient there?**

✓ 5–7. What is a progressive coronary unit? How does it help when the patient is moved to a private room?

★ **5–8. During the rest of the time in the hospital, the patient's heart begins to heal. Is the patient kept completely inactive? Why?**



★ **5–9. When the patient is released from the hospital, what do the doctors advise regarding exercise, diet, smoking, and general life-style?**

✓ 5–10. Is every heart attack patient given the same directions? Why?

✓ 5–11. What suggestions for good health do doctors make for persons who have recovered from heart attack?

5-6. The amount of time in the intensive care unit is usually from 24 to 72 hours. The purpose of keeping the patient there is to monitor the heart to judge if the patient's condition has stabilized.

5-7. The progressive coronary unit monitors the patient's condition while he or she is in a private room.

5-8. No. The patient is encouraged to take some exercise to prevent complications and general physical weakness.

5-9. Gradual increase in physical activity under doctor's direction; controlled diet; no smoking; relaxed and optimistic approach toward life; avoidance of tension-producing situations.

5-10. No. Directions depend upon the seriousness of the attack and the conditions that led to the attack.

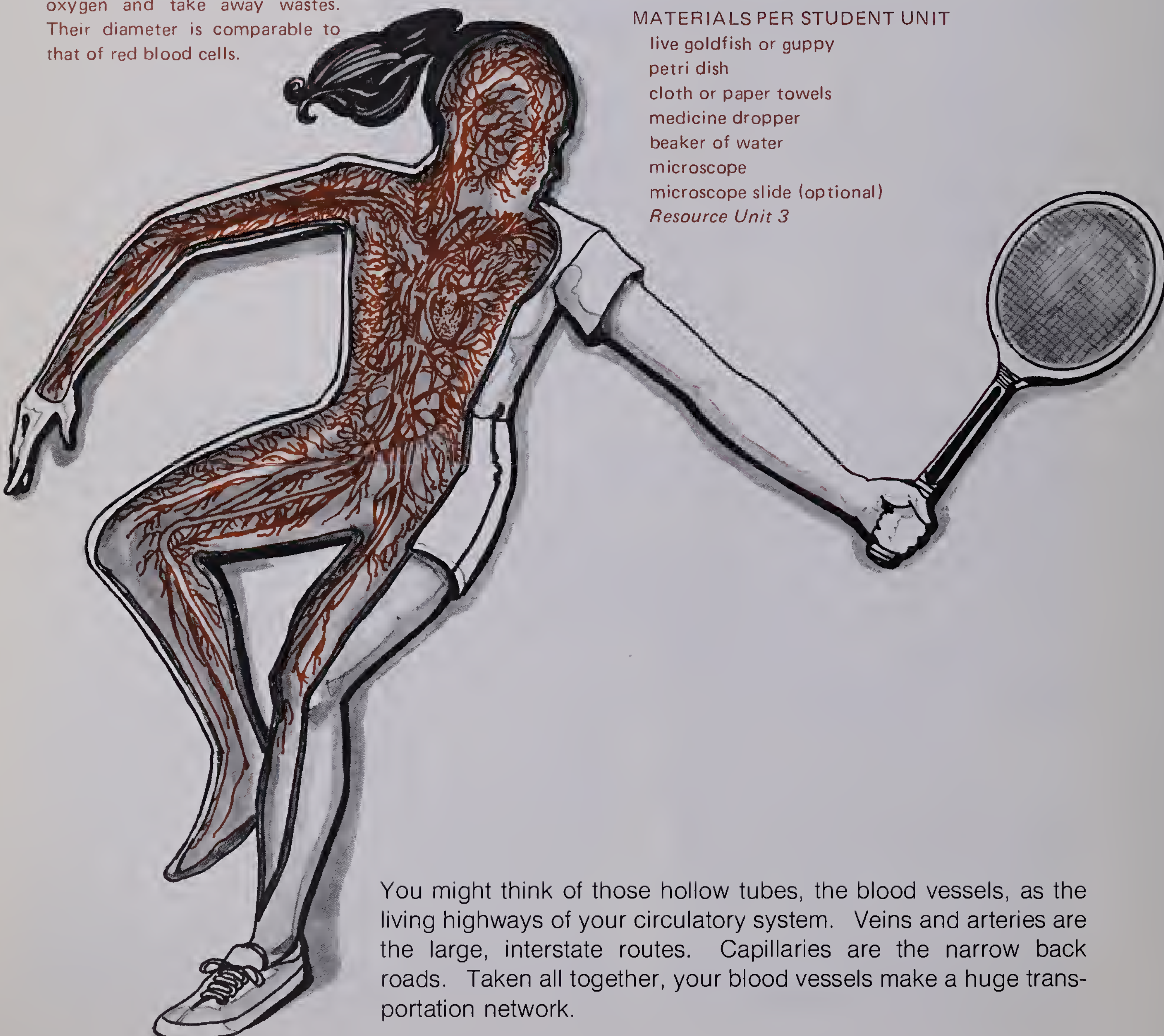
5-11. Avoid strenuous physical activity and mental stress. Avoid smoking and being overweight. Diet should be controlled. Above all, the patient should be optimistic about leading a normal life within certain limitations.

Getting Blood to the Cells

ACTIVITY EMPHASIS: Capillaries are the tiny, thin-walled blood vessels that supply the individual body cells with food and oxygen and take away wastes. Their diameter is comparable to that of red blood cells.

Inside you is an efficient transportation system. As your heart pumps blood, hollow tubes carry that blood to some part of your body and back again in less than a single minute.

MATERIALS PER STUDENT UNIT
- live goldfish or guppy
- petri dish
- cloth or paper towels
- medicine dropper
- beaker of water
- microscope
- microscope slide (optional)
- *Resource Unit 3*



You might think of those hollow tubes, the blood vessels, as the living highways of your circulatory system. Veins and arteries are the large, interstate routes. Capillaries are the narrow back roads. Taken all together, your blood vessels make a huge transportation network.

Figure 6–1 shows a very simple diagram of your blood's transportation system. Since it is a closed system, you can start anywhere to trace the route the blood follows. In Figure 6–1, start at Position 1, where the blood is leaving the heart. The blood then flows into the arteries (Position 2), which lead to all parts of the body.

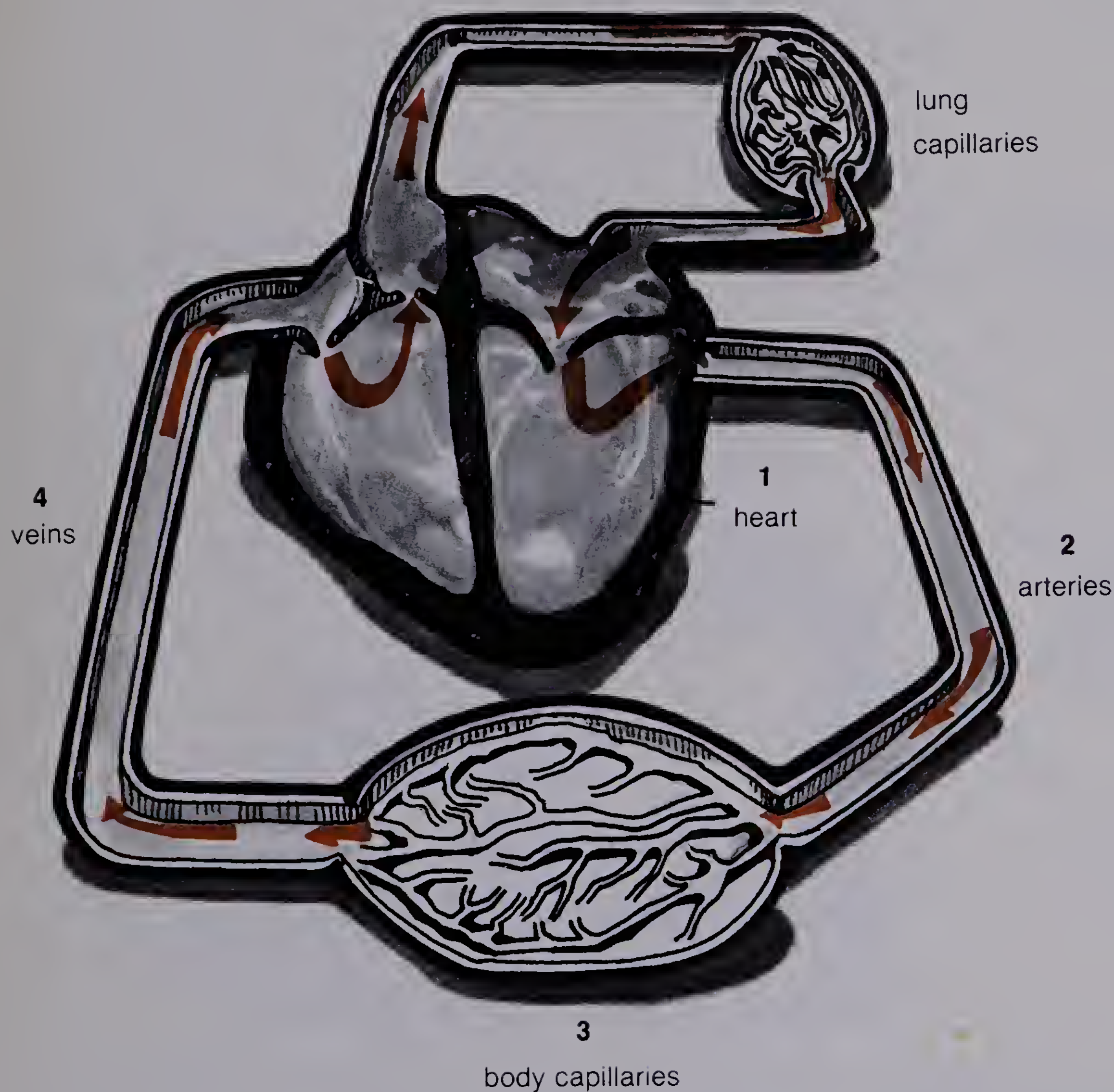


Figure 6–1

The plasma, or liquid part of the blood, is the part that supplies cells with food. It also carries away the cells' waste materials. To do all this, the plasma must touch every living cell in the body. The capillaries (Position 3) are the blood vessels that supply the individual cells. Capillaries have very thin walls, only one cell thick, so the liquid can pass through them to wash directly over each cell. In Position 4, the blood returns to the heart through the veins.

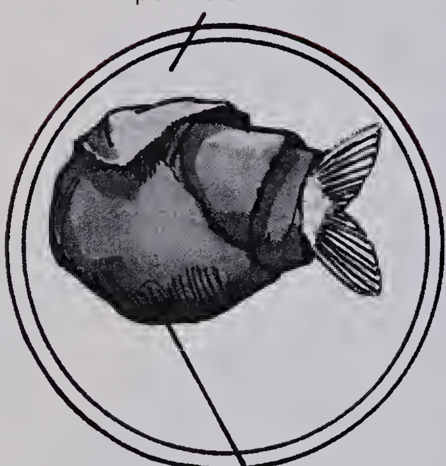
A frog may be used in place of the fish. For setup if a frog is used, see "Activity 6—Alternative" under Advance Preparation on page TM 6.

Veins and arteries are taken up in Activities 8 and 10. For now, focus on the thousands of capillaries spreading throughout your body. Actually, you'll have to focus on the capillaries in a fish, because yours are hidden by thick membranes. To get a good look at capillaries, you will need the following:

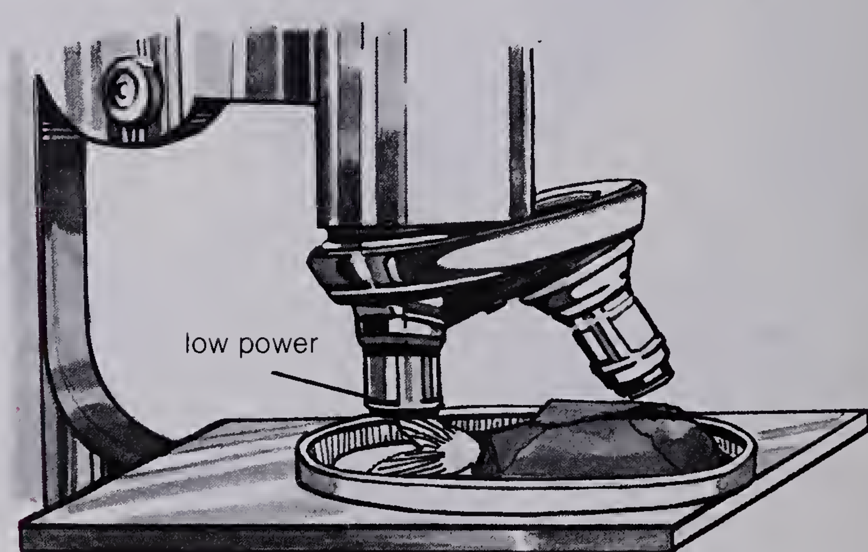
live goldfish or guppy
petri dish
cloth or paper towels
medicine dropper
beaker of water
microscope

Have *Resource Unit 3* available for aid in microscope usage.

You need to know how to use a microscope for this activity. If you have not already done *Resource Unit 3,* do it now before going on.



A. Wrap the fish gently in a wet cloth or paper towel, but leave the tail uncovered. Place the fish in a petri dish. Wet the tail and the bottom of the dish. Add a few drops of water every two or three minutes to keep the tail moist.



Enough towel must be used to keep the fish moist and quiet for 10 to 20 minutes, the maximum amount of time to keep the fish out of water.

B. Place the dish on the stage of the microscope. Position the dish so that a strong light comes through the thin tissue of the fish's tail. Look at that area under low power. You should be able to see vessels of different sizes.

A microscope slide over the fish's tail will help spread it out.

6-1. Blood flows faster in the larger vessels. The blood cells are slowed down in the smaller vessels because they have to squeeze through a smaller diameter.

✔ 6–1. Blood flows at different speeds in blood vessels. Is blood flow faster in the larger or smaller vessels? Why do you think this is so?

You won't need the fish again during this activity. If you have answered Question 6–1, return the fish to its tank or jar now.

In people or in fish, capillaries are such narrow tubes that the red blood cells must pass through them single file. So if you know the size of a red blood cell, you can estimate the diameter of a capillary.

A typical human red blood cell is shown in Figure 6–2. Looking down on the cell, you can see it has a circular outline with a depression in the center. Because of the depression, the cell looks like a dumbbell from the side. Red blood cells are so small that they have to be measured in millionths of a metre. One-millionth of a metre is called a *micron*.

Figure 6–3 shows a drawing of a cross section through a capillary. A red blood cell is traveling with the plasma through the capillary.

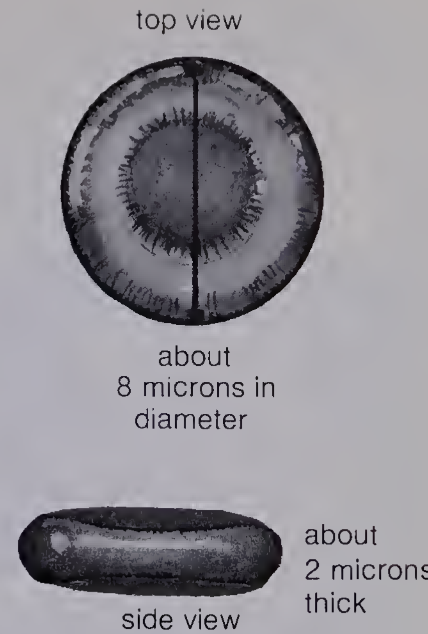
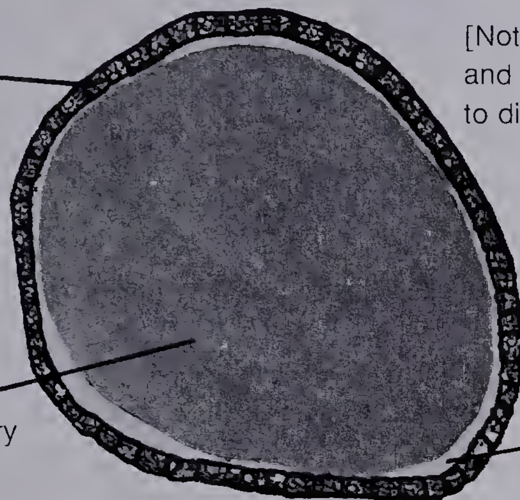


Figure 6–2



[Note: Figures 6–2 and 6–3 are drawn to different scales.]

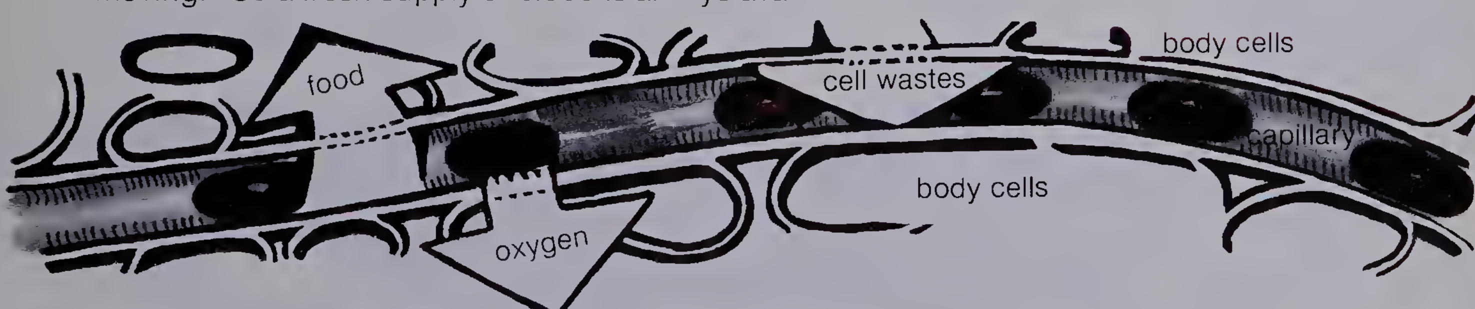
Figure 6–3

✓ 6–2. From Figures 6–2 and 6–3, how wide do you think a typical capillary is?

At times, red cells become folded as they squeeze through the smallest capillaries, indicating a diameter of less than 7 or 8 microns in those capillaries.

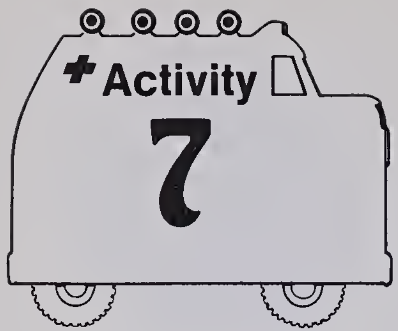
6-2. At least 8 microns. (Capillary diameters are actually 7 to 10 microns.)

The capillaries are action sites for cell nourishment. The liquids, gases, and some solids in the blood can pass through the capillary walls to supply the body cells. And waste from the cells can flow through the capillary walls to be carried away by the blood. Pressure from the blood in the arteries keeps the capillary blood moving. So a fresh supply of blood is always available to the cells.



★ **6–3. What two things do capillaries supply to the body cells that keep the cells alive? What do capillaries take away from the body cells?**

6-3. Capillaries supply cells with food and oxygen and take away waste materials.



Detection and First Aid

MATERIAL PER STUDENT UNIT

None.

ACTIVITY EMPHASIS: Overt symptoms of heart attack and stroke are quite different, such as severe chest pains for a heart attack versus dizziness and loss of speech or vision for a stroke. But the immediate actions to take are the same for both.

You may want to use this activity as a springboard to carry out first-aid training as a large-group exercise. Other first-aid information is included in Excursion Activities 17 and 20.

When blood flow is blocked from the muscle cells of the heart, those cells die. The person has a heart attack. When blood is blocked from cells in the brain, the person has a stroke. When heart cells or brain cells die, the whole person may die.

Quick action is vitally important. You should know the signs of stroke and heart attack and what to do about them. You may someday save a life, maybe even your own.

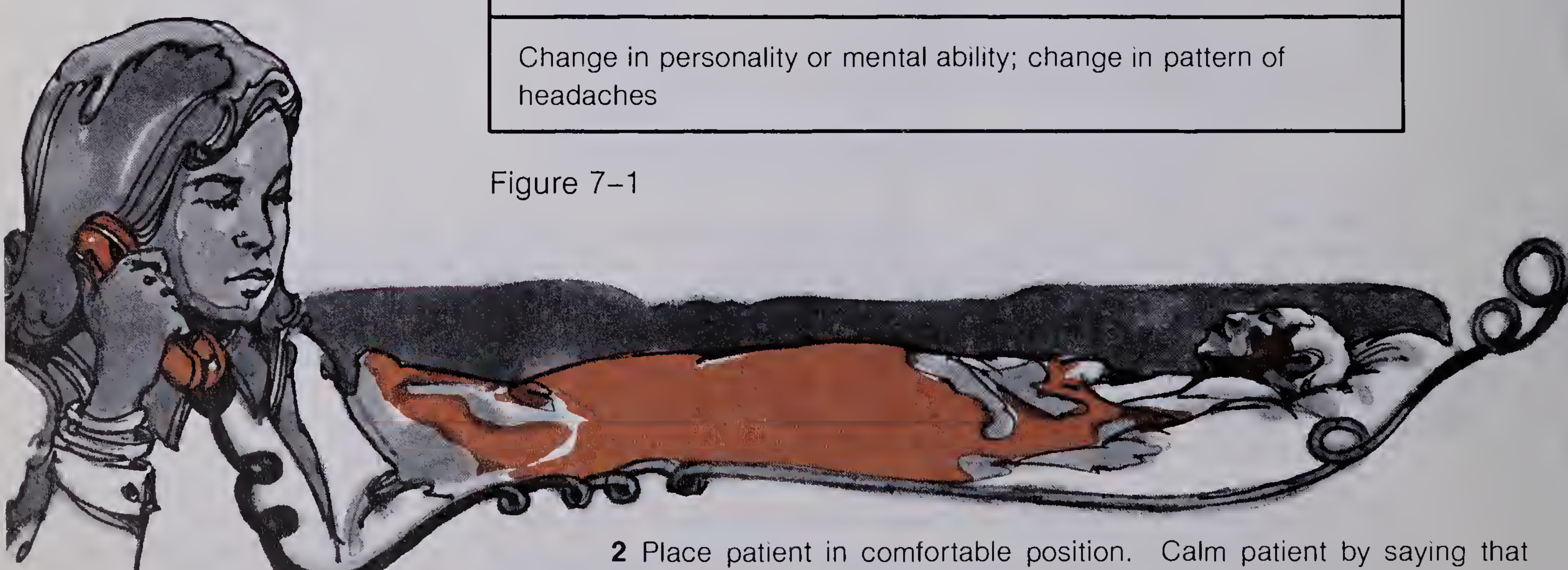
A person who has had a stroke will show different symptoms than a person who has had a heart attack. Figures 7–1 and 7–2 give the two sets of symptoms. The pictures on these two pages show the immediate actions to take.

SYMPTOMS OF A STROKE

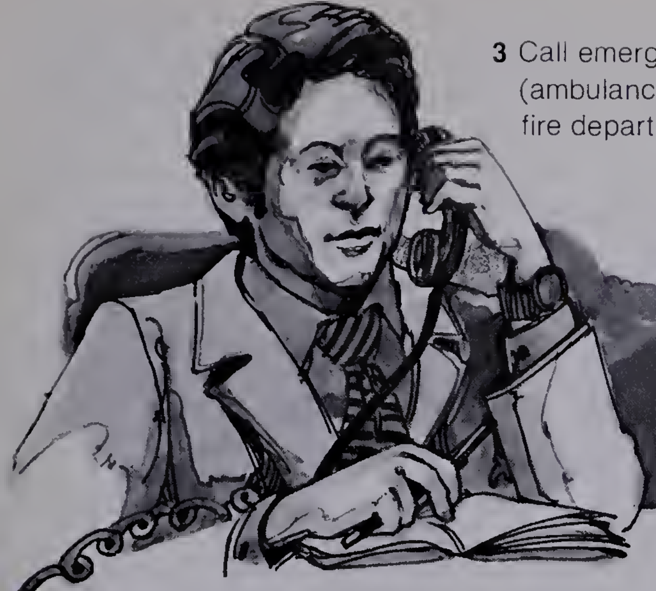
Sudden, temporary weakness or numbness of face, arm, or leg
Temporary difficulty or loss of speech, or trouble understanding speech
Temporary dimness or loss of vision, particularly in one eye (double vision)
Unexplained dizziness or unsteadiness
Change in personality or mental ability; change in pattern of headaches

Figure 7–1

1 Act fast — the first few minutes count!

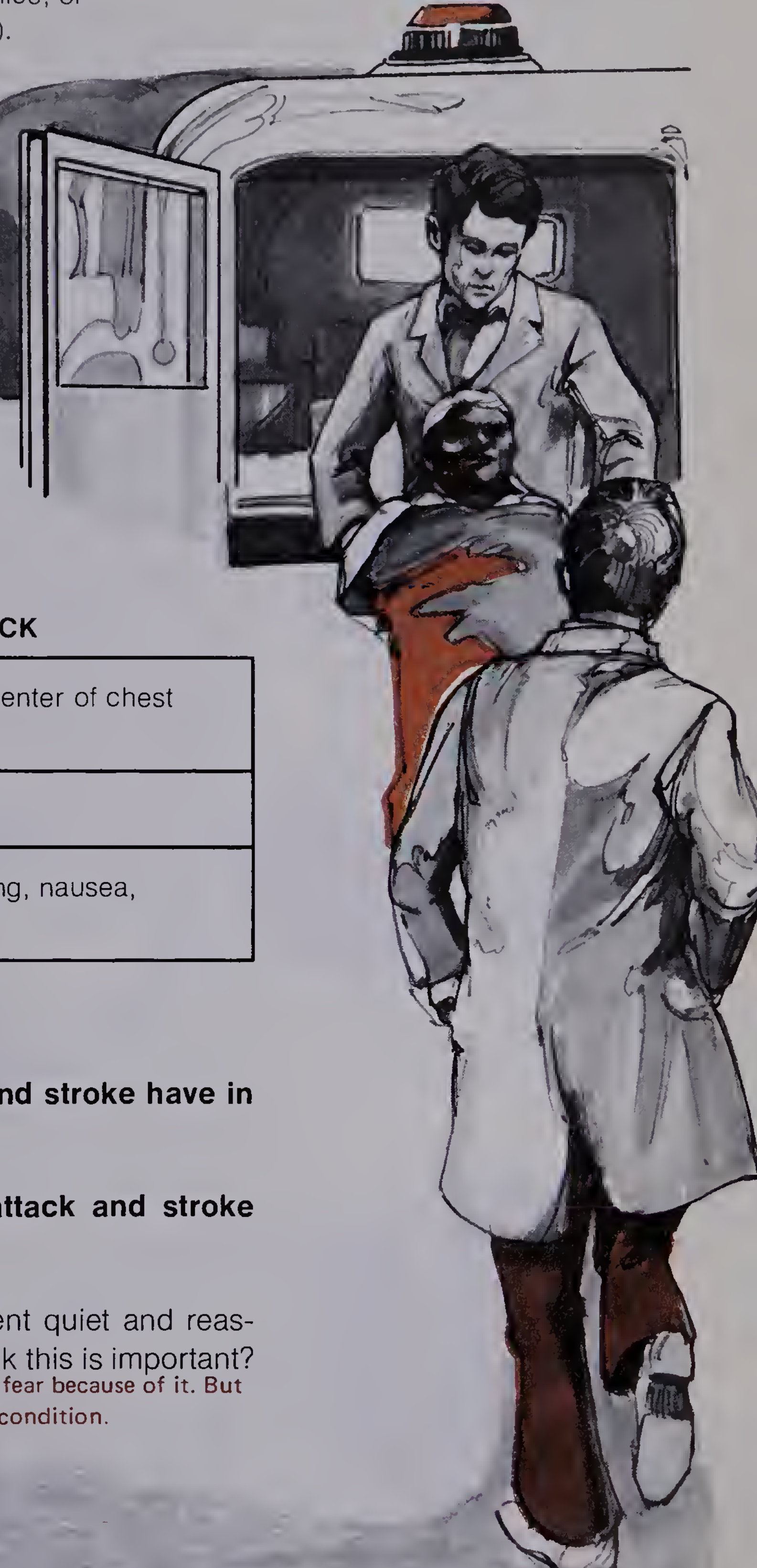


2 Place patient in comfortable position. Calm patient by saying that help is on the way.



3 Call emergency service (ambulance, police, or fire department).

4 Get patient to hospital emergency room at once.



SYMPTOMS OF A HEART ATTACK

Prolonged heavy pressure or squeezing pain in center of chest behind breastbone
Pain may spread to shoulder, arm, neck, or jaw
Pain or discomfort often accompanied by sweating, nausea, vomiting, shortness of breath

Figure 7–2

★ **7–1. What symptoms do heart attack and stroke have in common?** 7-1. None.

★ **7–2. Do the first-aid steps for heart attack and stroke differ in any way? If so, how?** 7-2. No.

✓ 7–3. It is also important to keep the patient quiet and reassured that help is on the way. Why do you think this is important?
7-3. A victim of a heart attack or stroke experiences great fear because of it. But getting too emotional and upset will only worsen his or her condition.

5 Don't leave the decision to act up to the patient.

Right after a heart attack, the greatest risk is that the victim's heart might stop beating. That means certain death unless the heart can be started again within about four minutes. The essential thing is to keep oxygen-carrying blood flowing to the brain. A trained person can do this by combining mouth-to-mouth resuscitation with a heart massage technique. Only mouth-to-mouth resuscitation is shown in Figure 7–3.

CAUTION

Do not attempt heart massage without professional training.

Even under trained hands, cardiopulmonary resuscitation is a chancy procedure. Liver damage, lung contusions, and broken bones are not uncommon consequences, but a small price, considering the alternative.

1. Clear any material from victim's mouth.

Serious injuries have resulted when untrained people have tried to use the heart massage technique. If you want to learn more about it, your local Red Cross can provide information and training.

During heart massage, a trained person sets up a rhythm of pressing against the chest over the victim's heart and then releasing the pressure. It is important to know the exact spot to press against. If the wrong spot is pressed, other organs may be damaged.

2. Place hand under victim's neck and lift upward. Keep victim's head tilted back.

3. Pinch the nose closed.

4. Blow air hard into the mouth.

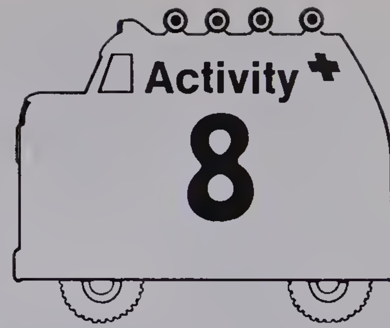
5. Listen for the victim to breathe out.

Figure 7–3

Mouth-to-mouth resuscitation puts oxygen into the victim's lungs. The action of heart massage pushes the blood out of the heart to pick up the oxygen and keep the brain supplied. When applied together, the two actions are called *cardiopulmonary resuscitation*. (*Cardio* refers to the heart and *pulmonary* refers to the lungs.) The procedure must be continued until the heart starts beating again on its own.

You might emphasize that mouth-to-mouth resuscitation alone will not start a heart beating again.

Going and Coming



Blood moves away from the heart through arteries. Blood returns to the heart through veins. The arrows in Figure 8–1 show the directions of blood flow in arteries and veins.

ACTIVITY EMPHASIS: Blood moves away from the heart through thick-walled, elastic and muscular arteries; it returns through the thinner-walled veins with the help of vein valves. Pulse is the result of the stretching and springing back of the arterial walls. Pulse rates differ among individuals.

MATERIALS PER STUDENT UNIT

Resource Unit 1

timepiece with second hand

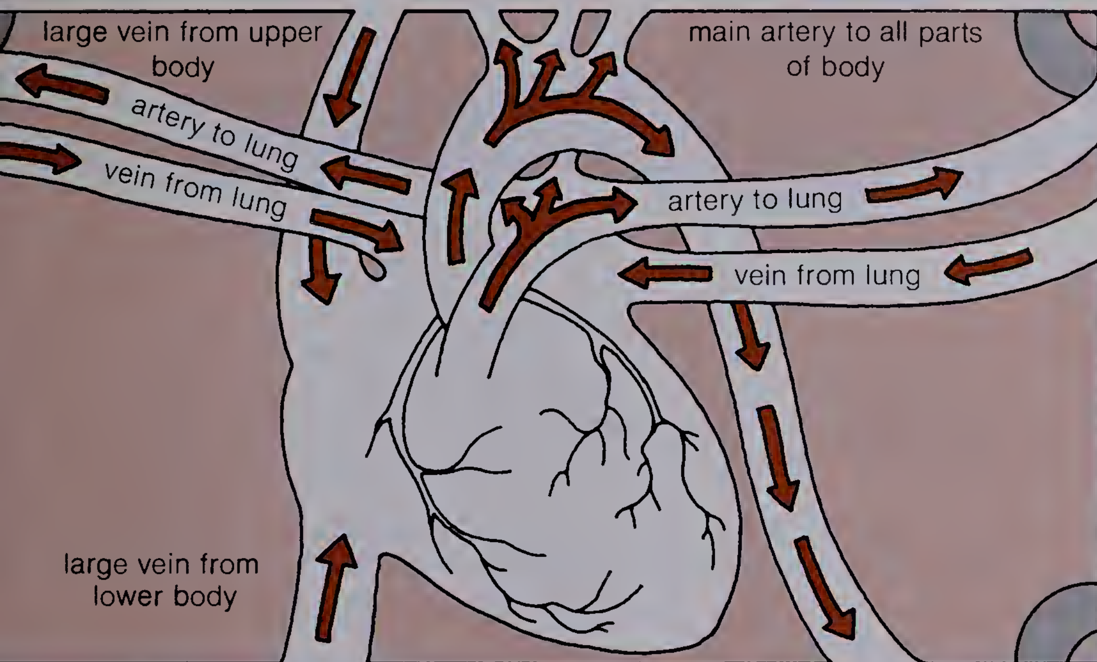


Figure 8–1

Veins and arteries are biggest near the heart. Away from the heart, they get smaller and smaller as they branch again and again. A few large tubes are thus divided into thousands of almost invisible capillaries. The thousands of capillaries supply blood to all the cells of the body. As each living tube changes in size, the thickness and makeup of its walls also change. Figure 8–2 shows this.

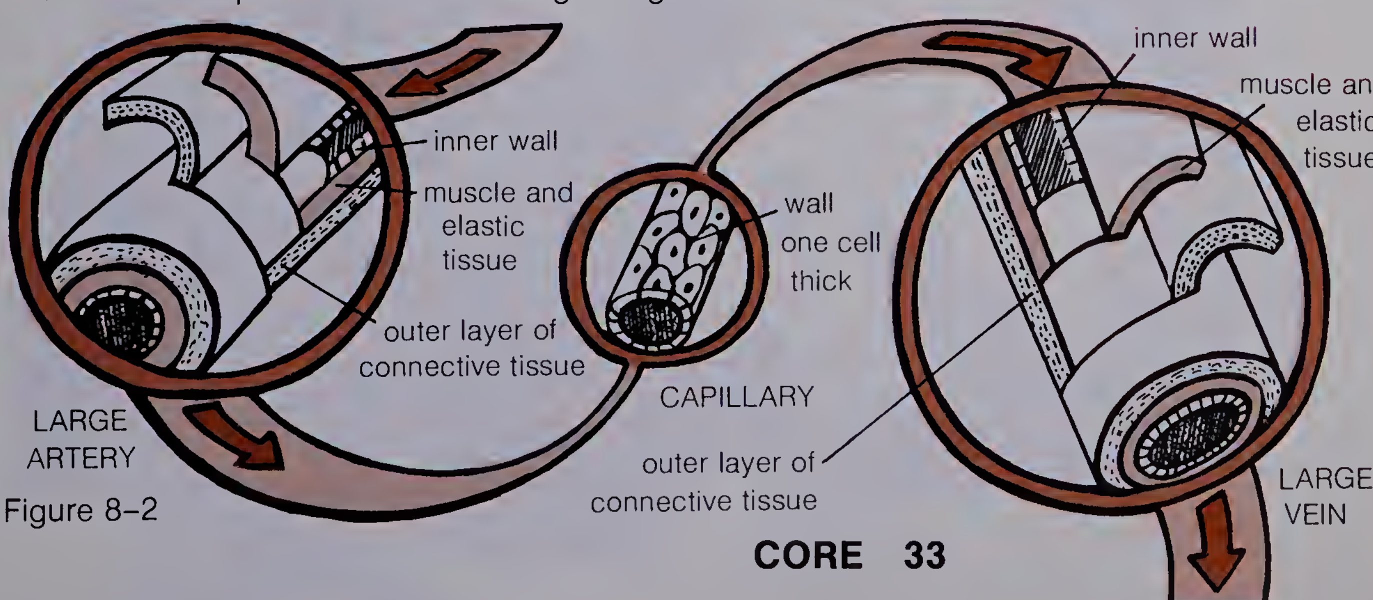


Figure 8–2

For a more detailed description of the actual origin of the pulse, see Background Information on page TM 9.

Arteries have thick walls of muscle and elastic tissue that help push blood along. Every pump of the heart sends out a surge of blood. As this surge arrives along each portion of an artery, it forces the arterial wall outward (see Figure 8–3). As the surge passes on, the elastic, muscular wall springs back, giving the blood an extra boost. This action of stretching and springing back produces a pulse.

Figure 8–3

8-1. Continuous surges of blood stretch the elastic, muscular walls, which spring back after each surge. Each time the walls spring back, they push the blood ahead. This happens at all points along the artery, so the blood keeps getting pushed until it reaches the capillaries.

✓ 8–1. How do the elastic, muscular walls of the arteries help move blood along to the capillaries?

Have *Resource Unit 1* available for aid in finding averages.

Before going on, see if you can average these four numbers: 62, 78, 70, 82. Check your answer with the one at the bottom of this page. If you got a wrong answer, do *Resource Unit 1* now, then return to this activity.

Try to find your pulse. Turn one hand palm upward. With the fingertips of your other hand, press gently on the underside of the wrist as shown. You may need to shift your fingers around until you find your pulse.

Answer
73

You can use your pulse to check on your circulation. Your pulse rate, for example, should be about the same in both arms. Copy the table in Figure 8–4 into your record book. Get a watch or clock with a second hand. Then record your data for each of the following steps:

1. Count your pulse for one minute. (Or, count your pulse for 15 seconds, then multiply by *4* to get the rate for one minute.)

2. Repeat the count a second time for the same arm.

3. Average the two values to get your average pulse rate for that arm.

4. Switch arms and repeat Steps 1, 2, and 3.

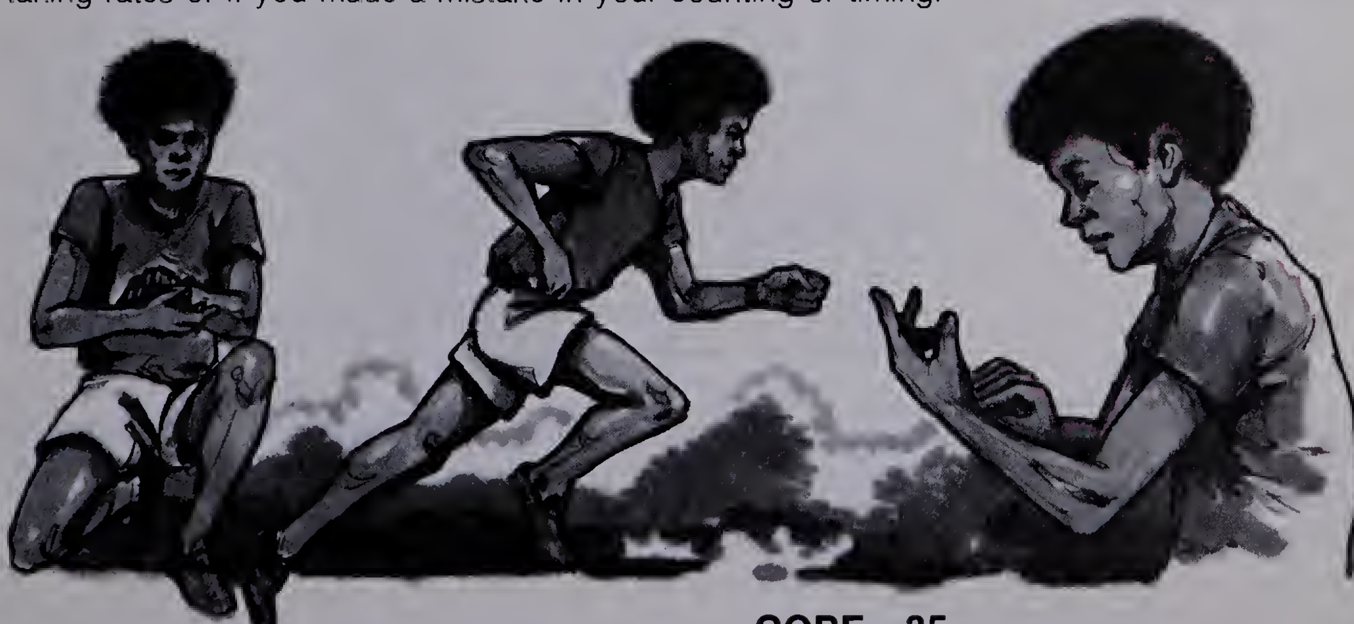
RESTING PULSE RATE

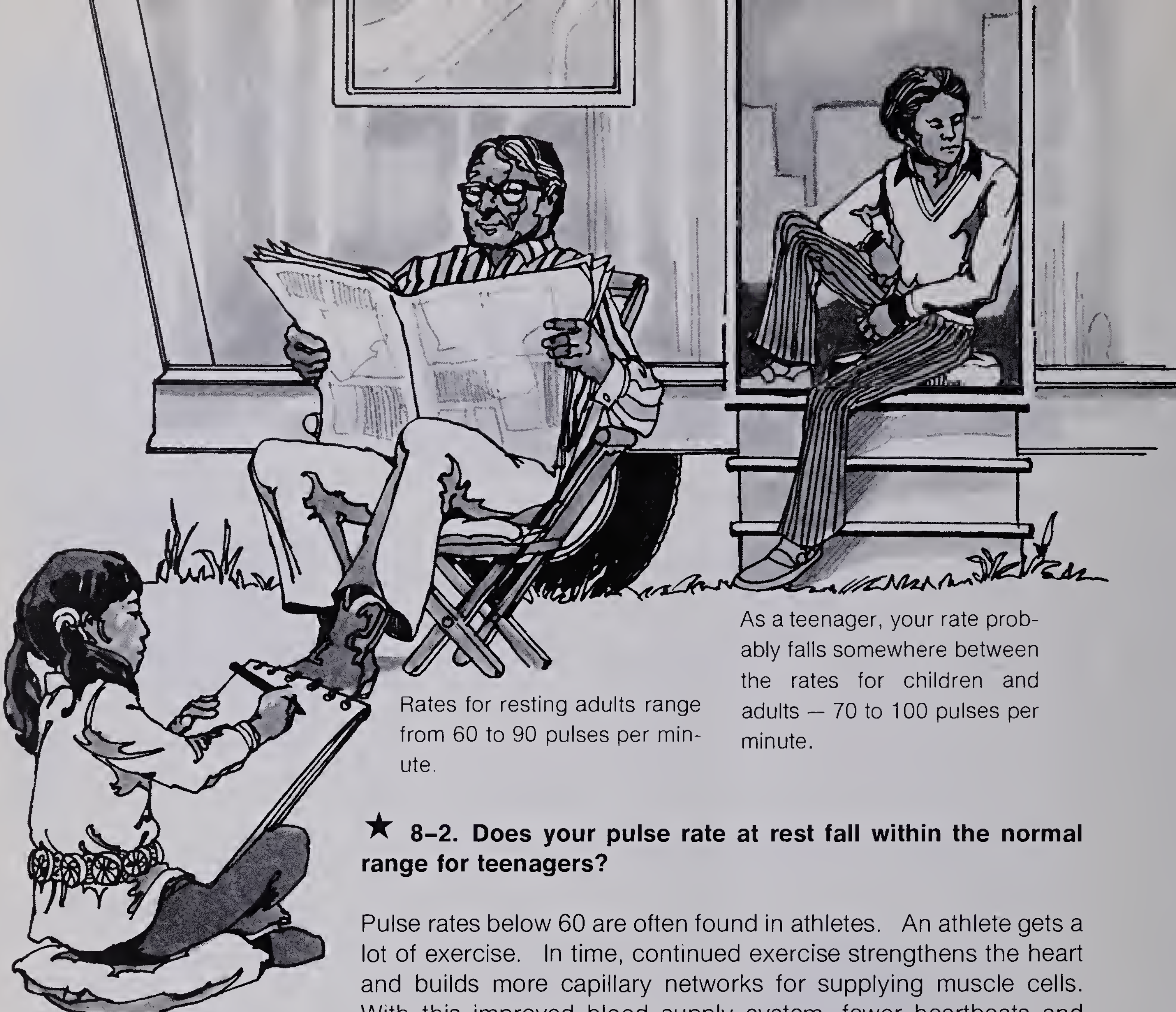
TRIAL	**COUNT IN RIGHT ARM**	**COUNT IN LEFT ARM**
1		
2		
Average		

Figure 8–4

Pulse rates in the two arms may differ under certain conditions. See Background Information on page TM 9 for discussion of this.

The pulse rate in your two arms should be about the same. The rates may be different, of course, if your activity changed between taking rates or if you made a mistake in your counting or timing.





Normal pulse rates for children at rest range from 90 to 120 pulses per minute.

Rates for resting adults range from 60 to 90 pulses per minute.

As a teenager, your rate probably falls somewhere between the rates for children and adults — 70 to 100 pulses per minute.

★ **8–2. Does your pulse rate at rest fall within the normal range for teenagers?**

8-2. Depends on the individual. The normal range would be between 70 and 100 pulses per minute.

Pulse rates below 60 are often found in athletes. An athlete gets a lot of exercise. In time, continued exercise strengthens the heart and builds more capillary networks for supplying muscle cells. With this improved blood supply system, fewer heartbeats and pulses of blood are needed to supply body cells.

Your pulse rate is different when you are "at rest" than when you are exercising. Count your pulse rate while standing for one minute. Record the count in your notebook. Then count and record your pulse rate after you have run in place for one minute. Compare your two counts with the counts of one or more classmates.

Running in place may raise the pulse rate as high as 150 pulses per minute, depending on how energetically the student runs. Very strenuous exercise may raise a pulse rate as high as 180 pulses per minute.

★ **8–3. While standing, do different people have different pulse rates? While running?** 8-3. Yes; yes.

✓ 8–4. Describe how you would find out whether being excited affects your pulse rate.

8-4. The next time you feel really excited about something, count your pulse for one minute. See how the count compares with your count at rest.

✓ 8–5. What is actually being felt when the pulse is taken?

8-5. A pulse is when one portion of an artery stretches and then springs back.

Now you know something about arteries and how they get blood to the capillaries. Blood flows back from the capillaries through the veins, which are built like arteries but have less muscular walls. You can see this if you look back at Figure 8–2 on page 33.

The blood that flows back to the heart is no longer under much pressure. Passing through the tiny capillaries has slowed it down. So the blood reacts slowly to pulses from heartbeats.

To prevent this sluggish blood from changing direction and moving away from the heart, many veins in the body have built-in, one-way valves. As Figure 8–5 shows, these valves are opened by blood traveling toward the heart. If the blood starts to fall back, the valves are closed.

Interested students can locate some of their own vein valves in Excursion Activity 19.

Valve pushed open by blood moving toward heart.

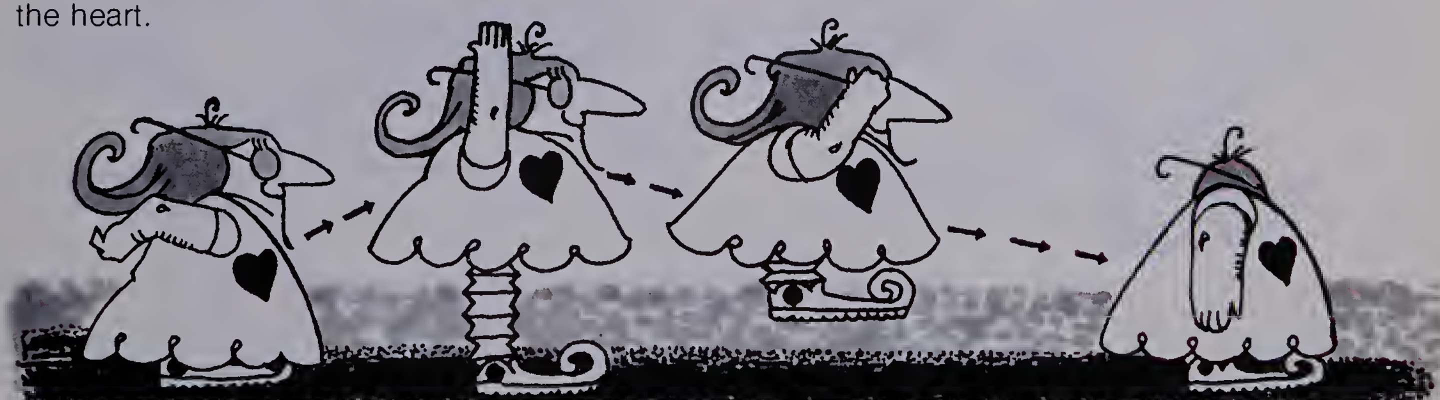
Valve closes, stopping backflow of blood away from heart.

Figure 8–5

★ 8–6. How do the valves in veins help blood flow to the heart?

8-6. These are one-way valves that keep the blood moving to the heart. If the blood starts to go the other way, the valves close.

For the one-way valves to work properly, you have to move once in a while. Otherwise, the pull of gravity will trap blood in the lower body areas. If there is not enough muscular motion, the brain cells receive less blood, and dizziness or fainting can result. This doesn't mean you have to jump up and down a lot. Any movement of muscles will squeeze the veins and help move the blood back to the heart.

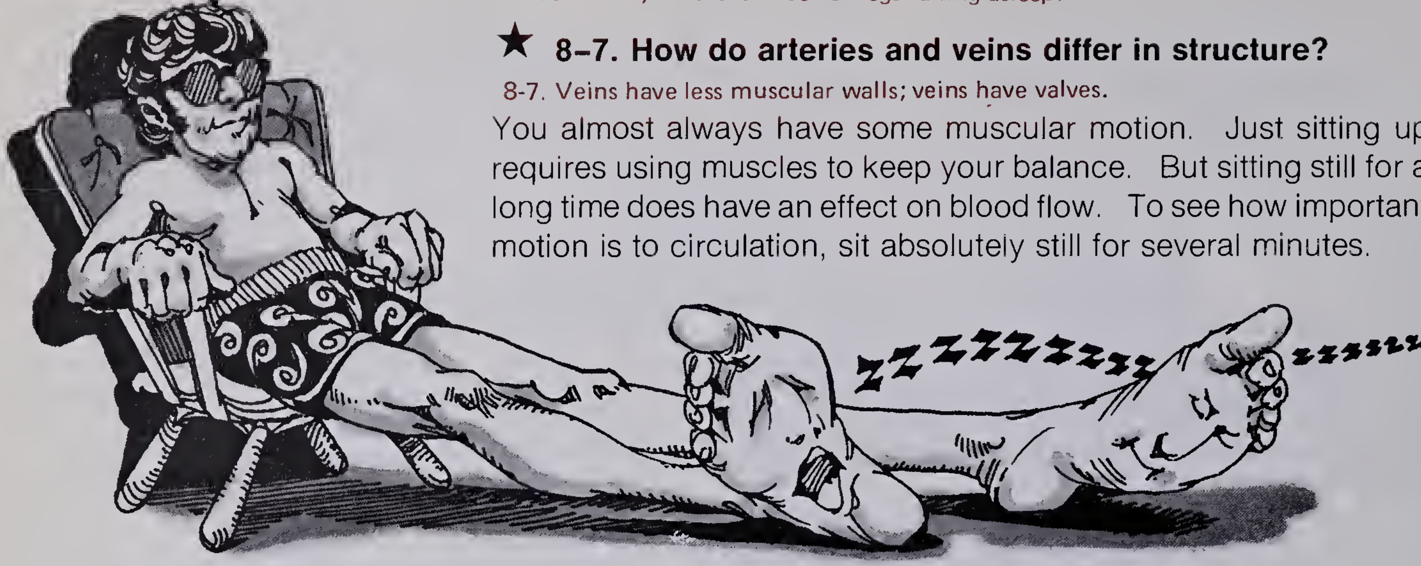


Students may find their feet or legs falling asleep.

★ **8–7. How do arteries and veins differ in structure?**

8-7. Veins have less muscular walls; veins have valves.

You almost always have some muscular motion. Just sitting up requires using muscles to keep your balance. But sitting still for a long time does have an effect on blood flow. To see how important motion is to circulation, sit absolutely still for several minutes.



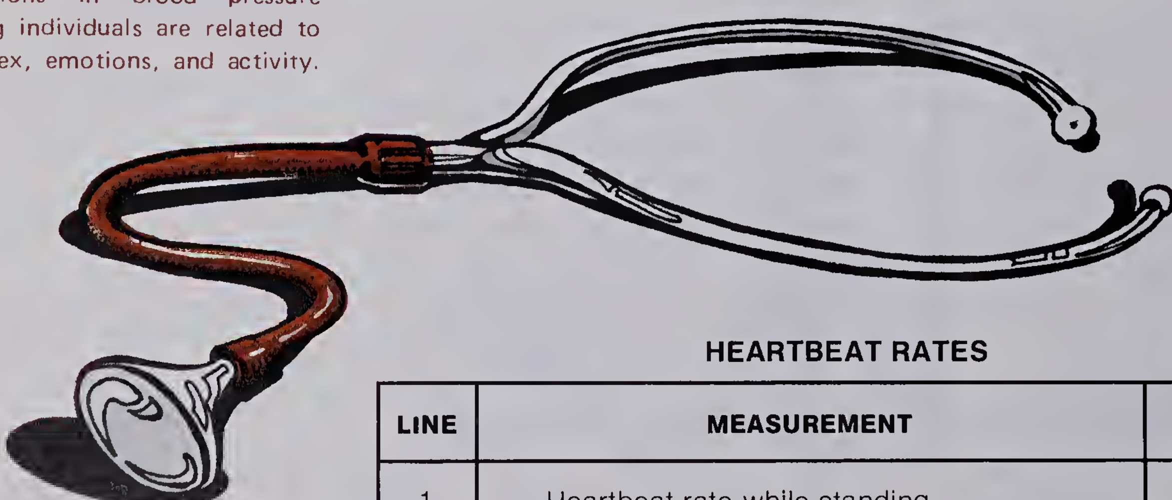
Activity 9

Heartbeat and Pressure

MATERIALS PER STUDENT UNIT
- stethoscope
- timepiece with second hand
- alcohol (optional)
- cotton ball (optional)
- sphygmomanometer
- *Resource Unit 2*

ACTIVITY EMPHASIS: Students count their own heartbeats and find each other's blood pressure. Variations in blood pressure among individuals are related to age, sex, emotions, and activity.

A single heartbeat sounds like "lub-dub." Keep that in mind as you check to see how fast your heart beats. First, copy Figure 9–1 into your record book. Then get a stethoscope and a clock or watch with a second hand.



HEARTBEAT RATES

LINE	MEASUREMENT	DATA
1	Heartbeat rate while standing	
2	Heartbeat rate after running	

Figure 9–1

IMPORTANT: Read through these three steps before you begin. Notice how quickly Step 3 follows Step 2.

Shortage of equipment may occur if too many students begin this activity at the same time. Encourage some of the students to do another activity or two, then return to this one.

1. While standing, count the number of heartbeats ("lub-dubs") you hear in one minute. Record your count in Line 1 of your table. You may want the earplugs of the stethoscope cleaned with a cotton ball soaked in alcohol before use.
2. Remove the stethoscope from your ears. Run in place for one minute.
3. Right away, count the number of heartbeats again for one minute. Record your count in Line 2.

To hear the heartbeat clearly, the stethoscope earplugs must be correctly positioned in the ears. Tell the students to relocate the earplugs if they are having trouble.

✔ 9–1. What effect does exercise have on your heartbeat rate?

✔ 9–2. Compare your findings with those of some classmates. Do different people have different heartbeat rates? 9-2. Yes.

9-1. Exercise increases the heartbeat rate. The rate may be raised as high as 150 beats per minute, depending on how energetically the student runs and on the condition of his or her heart.

Arteries carry blood away from the heart. When your heart squeezes blood out into the arteries, the blood pushes against the walls of the arteries. The result of that pushing is called the *blood pressure*.

Your body actually has two blood pressure levels. The higher level is called the *systolic* level. This occurs with each beat, or pump, of the heart. The lower level is called the *diastolic* level. This occurs between beats, when the heart is resting, or refilling, between pumps.

Check whether the sphygmomanometer to be used is different from the one shown here. You may need to explain any differences to the students.

Figure 9–2 shows a blood pressure measurer with its parts labeled. The real name for a blood pressure measurer is *sphygmomanometer* [sfig-mo-ma-NOM-et-er]. Not all sphygmomanometers look alike. If the one you'll be using looks different from the one shown here, check with your teacher for any special directions.

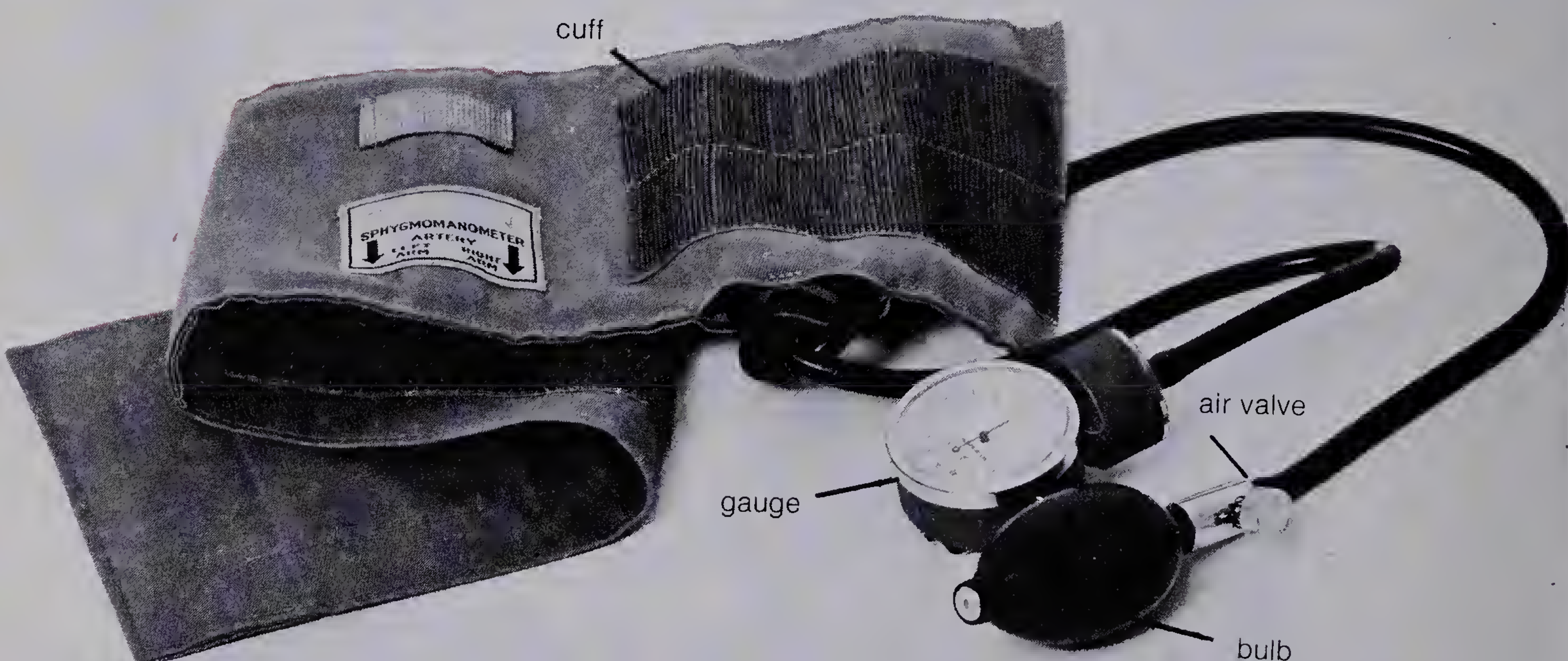


Figure 9–2

Student use of the sphygmomanometer should be monitored. Not only can the instrument be damaged, but arm circulation can be greatly impeded if a student wears the cuff for too long a time.

To measure blood pressure, you'll need the following:

a partner
sphygmomanometer
stethoscope

IMPORTANT: Read through the directions and be sure you understand the parts of the sphygmomanometer before you begin.

Emphasize the importance of the caution on Page 41.


BLOOD PRESSURE
BARE ONE ARM (RIGHT OR LEFT) AND EXTEND IT AT ABOUT HEART LEVEL.
L R
THE CUFF HAS A PATCH WITH TWO ARROWS. FOR THE RIGHT ARM, USE R ARROW. FOR THE LEFT ARM, USE THE L ARROW
FIND THE ARTERY THAT IS IN THE BEND OF THE ELBOW. WRAP THE CUFF SO THE CORRECT ARROW FALLS OVER THE ARTERY AND ONE INCH ABOVE IT. THEN FASTEN THE CUFF.
PUT ON THE STETHOSCOPE. HOLD THE DISK AGAINST THE ARTERY AT THE ELBOW. DO NOT TOUCH THE CUFF.
CLOSE THE AIR VALVE.
SQUEEZE AIR INTO THE CUFF UNTIL THE GAUGE READS ABOUT 160 mm.
160
80
240
0
BARELY OPEN THE VALVE AND SLOWLY LET THE AIR OUT AT A RATE OF 2 OR 3 mm/SEC. LISTEN FOR THE SOUND OF BLOOD PUMPING. WHEN YOU HEAR THE SOUND, RECORD THE GAUGE READING AS THE SYSTOLIC PRESSURE FOR THAT ARM.
160
240
0
CONTINUE LETTING AIR OUT AT THE SAME SLOW RATE. WHEN THE SOUND DISAPPEARS RECORD THE READING AS THE DIASTOLIC PRESSURE FOR THE ARM.
CAUTION
REPEAT THE MEASUREMENT AFTER WAITING AT LEAST 2 MINUTES. WAITING ALLOWS THE ARM'S CIRCULATION TO RETURN TO NORMAL. WORK WITH THE OTHER ARM WHILE YOU WAIT, OR HAVE YOUR PARTNER CHECK YOUR PRESSURE.

Errors in measurement may be the student's fault, but they may also be due to a faulty sphygmomanometer. See Background Information on page TM 8.

9-3. Answers will vary. (Range is from 100/60 to 135/90 for high school students; pressure levels in the two arms should be about the same.)

✔ 9–3. What are the systolic and diastolic blood pressure levels in your right arm? In your left arm? (Blood pressures are written like fractions, with the systolic pressure over the diastolic pressure. So you would write it as 000/00 for each arm.)

✔ 9–4. What are your partner's blood pressure levels in each arm? 9-4. Pressure levels should be about the same in both arms.

Figure 9–3 gives an idea of blood pressure levels in people of different ages.

AVERAGE BLOOD PRESSURES AT AGES 14–94

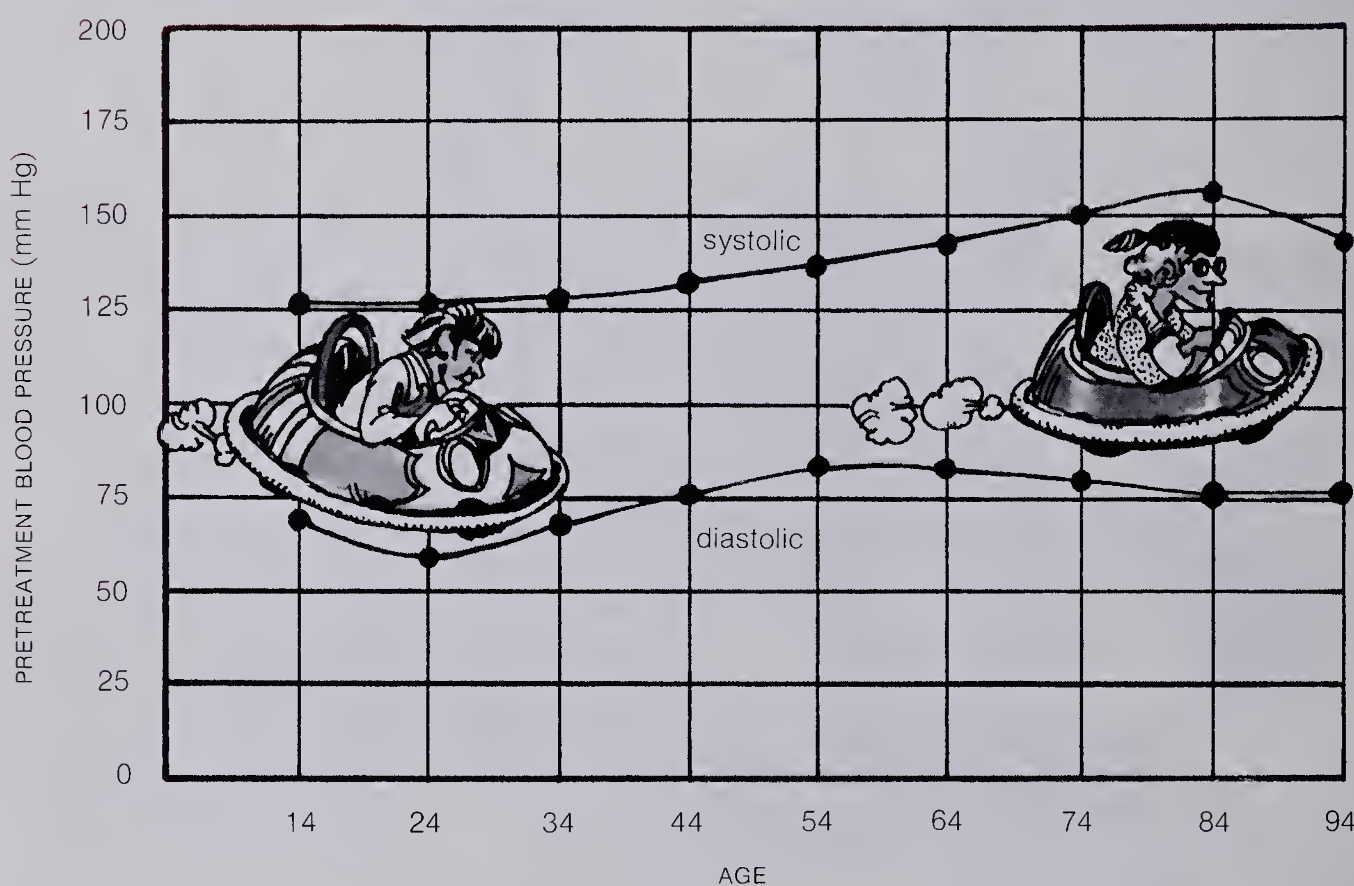


Figure 9–3

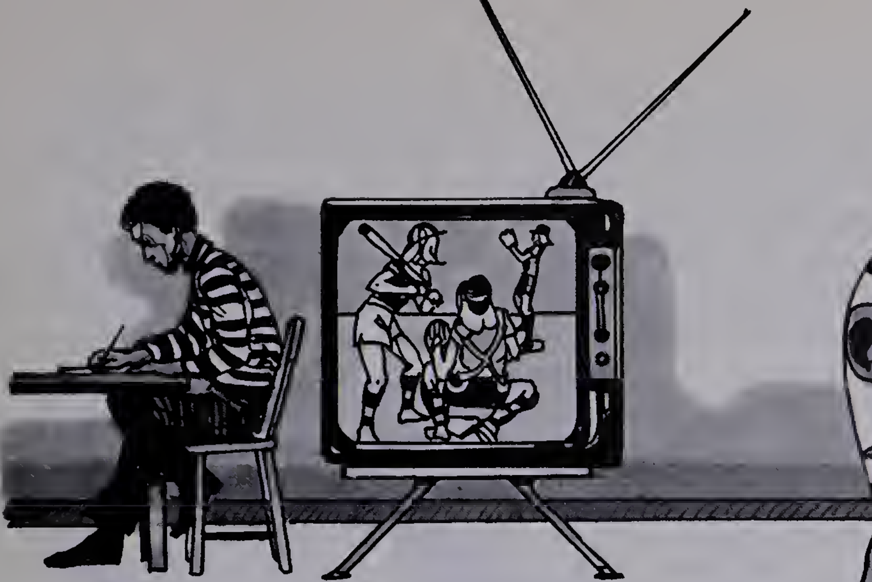
Have *Resource Unit 2* available for aid in reading graphs.

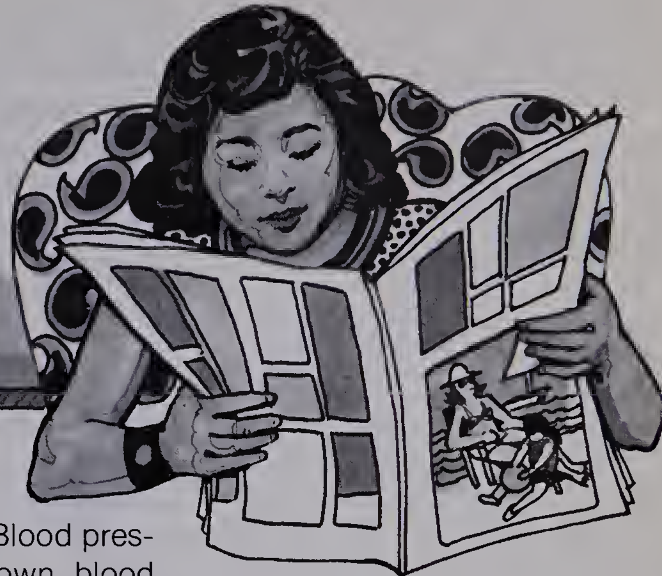
★ **9–5. According to Figure 9–3, what is the average diastolic pressure for persons of your age?** 9-5. 60 to 70 mm Hg

If you had trouble answering that question, do *Resource Unit 2* for help with reading graphs. It will help you with the next question too.

For interested students, Advanced Activity 13 deals with the causes of systolic and diastolic blood pressures.

★ **9–6. In general, up to about what age does the average systolic blood pressure show an increase?** 9-6. Up to age 84.





It is hard to say what your blood pressure should be. Blood pressures differ greatly among people. In fact, your own blood pressure isn't always the same. It varies with your emotions, your activity, and other factors.

The data in Figure 9–4 show how blood pressure varies within age categories.

NORMAL RANGES OF BLOOD PRESSURES IN MEN AND WOMEN

SYSTOLIC			DIASTOLIC		
Age	Male	Female	Age	Male	Female
16	105–135	100–130	16	60–86	60–85
20–24	105–140	100–130	20–24	62–88	60–85
25–29	108–140	102–130	25–29	65–90	60–86
30–34	110–145	102–135	30–34	68–92	60–88
35–39	110–145	105–140	35–39	68–92	65–90
40–44	110–150	105–150	40–44	70–94	65–92
45–49	110–155	105–155	45–49	70–96	65–96
50–54	115–160	110–165	50–54	70–98	70–100
55–59	115–165	110–170	55–59	70–98	70–100
60–64	115–170	115–175	60–64	70–100	70–100

Figure 9–4

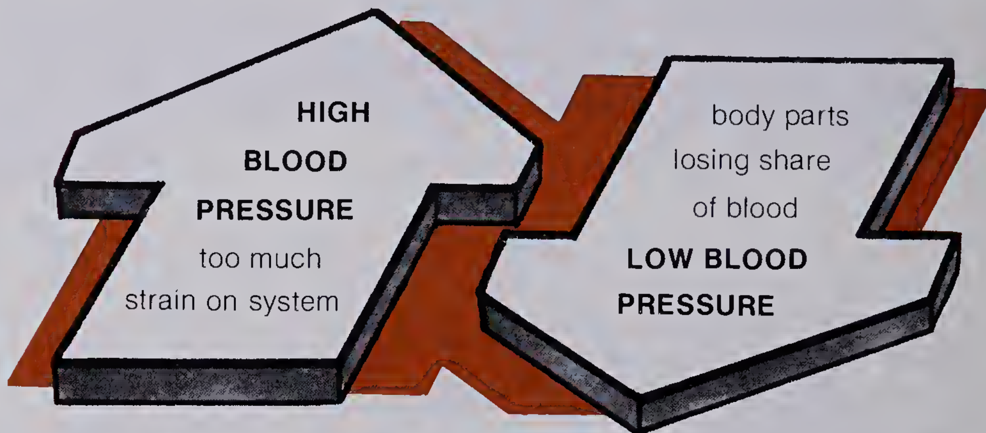
✓ 9–7. In general, do females or do males have higher blood pressures? 9-7. Males.

★ **9–8. Do your systolic and diastolic levels fall within the range for your age and sex?** 9-8. Depends on the individual.

Rule of thumb for too high blood pressure is anything over 140/90. If any student's reading concerns you, recommend a visit to the school nurse or a doctor.

Don't panic if your blood pressure seems too high. Have a doctor check it out. There are simple ways to control high blood pressure. But control it, don't ignore it.

A measure of your blood pressure can tell you about the condition of your circulatory system. Too high blood pressure means that your heart and vessels are constantly under strain. Such high pressure can also be bad for other body organs, especially your kidneys.



9-9. A blood pressure check will tell something about the condition of the heart and blood vessels. It is important to find out early if there is an abnormal condition.

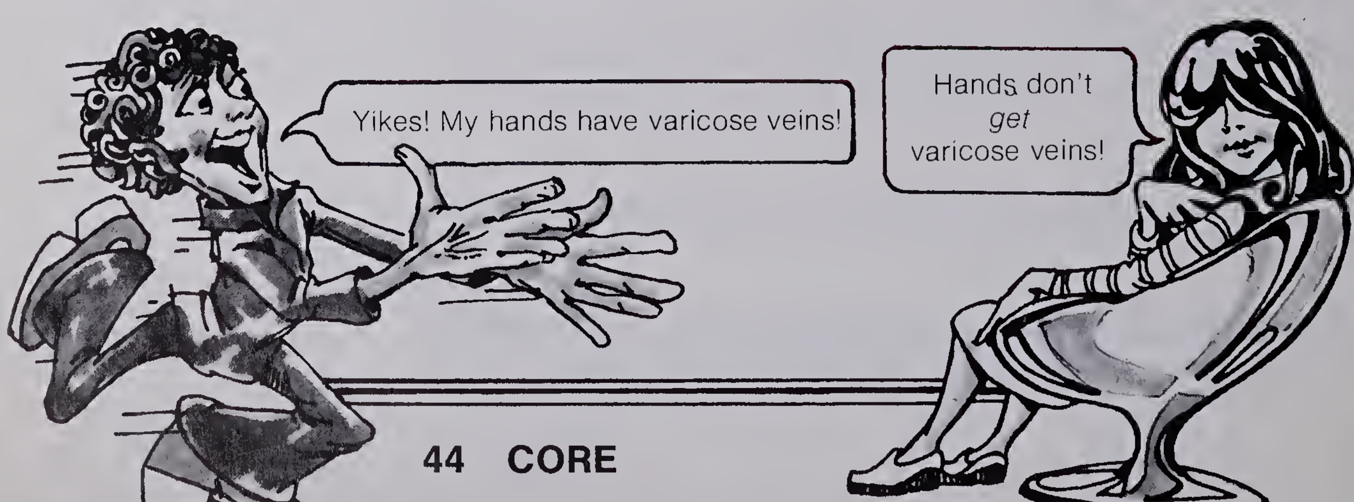
Very low blood pressure means the circulatory system isn't doing its job; not enough blood is getting to all the body parts.

✓ 9–9. Why is it important to have a blood pressure check as part of a physical exam?

ACTIVITY EMPHASIS: Four common diseases of the circulatory system are anemia, varicose veins, atherosclerosis, and systemic hypertension. Each disease has certain symptoms and recommended treatments.

Circulatory Diseases

Lots of symptoms mean lots of things. In doing this activity, don't panic if you decide you have some of the symptoms mentioned. Chances are, you don't have the disease. Tell your teacher if you're worried. MATERIALS PER STUDENT UNIT None.



Disease can hit all parts of the circulatory system. Some of the diseases are more common than others; some are more serious than others. This activity will give you a brief look at anemia, varicose veins, atherosclerosis (hardening of the arteries), and hypertension (high blood pressure). Each affects the system in a different way.

ANEMIA

Anemia is a disease of the blood. Blood is a complex and essential substance. It supplies your body cells with food and oxygen, and it carries away waste materials. Blood is composed of plasma, red and white blood cells, and platelets.

Other diseases of the blood that may be familiar to the student include leukemia, hemophilia, and blood poisoning. Some students may want to find out more about these diseases, their causes, symptoms, and treatment. Hemophilia is touched upon in Advanced Activity 15.

Doctors often look at blood when they are trying to find out what their patients are suffering from. They look especially at the red blood cells. Are the red cells the shape they should be? Are there too many or too few? If the red blood cells are shaped wrong or if there are too few of them, a doctor might suspect some form of anemia.

KINDS OF ANEMIA

DISEASE	COMMON SYMPTOMS	PROBLEM	TREATMENTS
Iron-deficiency anemia	Weakness; dizziness; headache; noises in ears; drowsiness; shortness of breath; continuous rapid heartbeat; loss of appetite.	Too few red cells due to blood loss or pregnancy, or not enough iron in diet.	Correct blood loss; add iron supplements to diet; stay active; eat a well-rounded diet.
Pernicious anemia	Weakness; heart palpitations; soreness of tongue; weight loss; numbness and tingling of hands and feet.	Stomach cannot absorb vitamin B_{12}, which is needed to produce healthy red blood cells.	Get vitamin B_{12} injections for rest of life; eat a well-rounded diet.
Sickle-cell anemia	Sore that won't heal; severe pain in chest, bone, or joint; blood in urine; severe indigestion; abdominal pain or continued vomiting; fainting; weakness.	Inherited abnormal red cells — easily destroyed and low in capacity to carry oxygen.	Take no aspirin in any form; eat a well-rounded diet. No known cure; blood transfusions may be necessary.

Figure 10–1

The most common anemia is iron-deficiency anemia. Loss of blood during menstruation increases the incidence of this type of anemia in women.

10-1. Well-rounded diet, including iron supplements.

★ **10–1. What is the basic treatment for iron-deficiency anemia?**

Sickle-cell anemia is an inherited disease and a big problem among the black population. People who inherit the disease factor from only one parent are called *carriers*. They carry a factor for the disease, but they don't get the disease. There is an advantage to this in regions where malaria occurs — it has been found that, for some reason, carriers of sickle-cell anemia don't get malaria.

However, in regions where malaria is not a threat, as in the United States, factors for sickle-cell anemia work only against survival. When the factors are inherited from both parents, the anemia is itself a deadly disease.

✔ 10–2. What is it about the blood cells that makes sickle-cell anemia a fatal disease? (Hint: Look back at Figure 10–1.)

10-2. The red blood cells can't carry enough oxygen to the body cells and are easily destroyed.

VARICOSE VEINS

Perhaps the most common disease of veins is varicose veins (see Figure 10–2). Varicose veins are veins that have stretched beyond normal size. They usually occur in the legs and pelvic region.

Healthy veins have valves (Figure 10–3) that prevent blood from moving back, away from the heart. If for some reason the valves don't close completely, two things happen:

1. Blood flows backward, out of the larger veins that lead to the heart and into smaller veins that lie nearer the skin. This extra blood weakens the smaller veins. Their walls become stretched and enlarged.

2. The deeper, larger veins carry less blood than they should, and the smaller, outer veins carry more blood than they should.

Figure 10–2

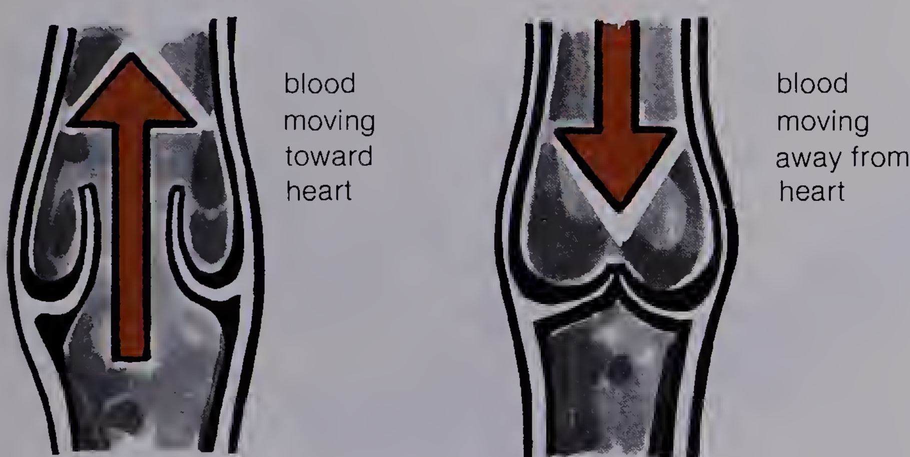


Figure 10–3

✔ 10–3. Why do you think varicose veins occur more often in the legs and pelvic region than in other parts of the body?

10-3. Gravity tends to pull the blood downward. So when a person stands a lot, the blood tends to pool in the legs. When a person sits a lot, the blood tends to pool in the pelvic region.

✔ 10–4. What lines of work may contribute to varicose veins?

10-4. Any job that requires a lot of standing or sitting will contribute to varicose veins. Standing in assembly lines, standing behind sales counters, and sitting at office desks are some examples.

As you saw in Figure 10–2, varicose veins are obvious once they have become greatly enlarged. But the disease can exist long before it becomes obvious to the eye. Other symptoms that may occur are described in Figure 10–4. Possible treatments for the condition are also described. Varicose veins will not heal by themselves.

VARICOSE VEINS

SYMPTOMS	FACTORS THAT WORSEN CONDITION	TREATMENTS
Swelling of legs; muscle cramps; soreness behind knee; itching of skin. (Symptoms among women may worsen during menstrual period and pregnancy.)	Prolonged standing; sitting with legs crossed; excessive weight or height; pregnancy; wearing tight garters or girdles.	Vein removed by surgery (commonly called *stripping*); avoid factors that worsen condition; elevate legs whenever possible while sitting; position foot of bed about 5 centimetres higher than head of bed; wear elastic stockings without tight elastic at top.

Figure 10–4

✓ 10–5. List three symptoms of varicose veins.

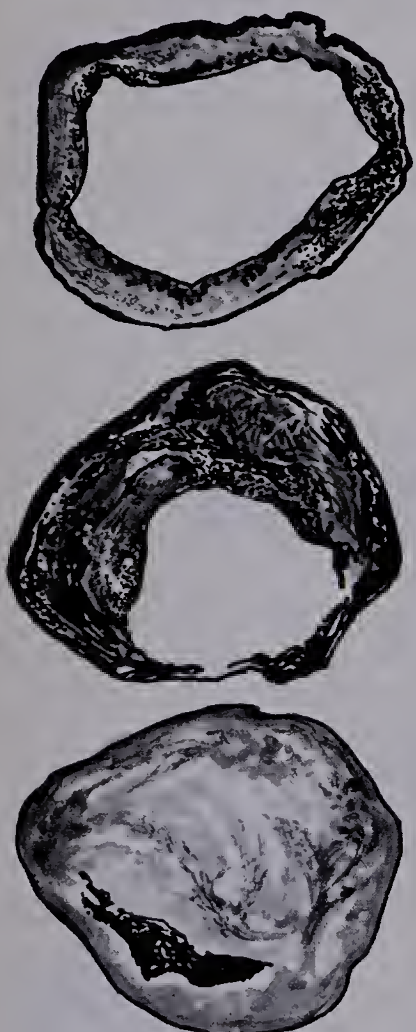
10-5. Swollen legs, muscle cramps, soreness behind the knees, itchy skin.

★ **10–6. One suggested treatment for varicose veins is sleeping in a bed where the foot of the bed is raised higher than the head of the bed. What is the reasoning behind this treatment?** 10-6. Raising the legs above the heart's level helps blood flow back to the heart because of gravity.

ATHEROSCLEROSIS

An important disease of the arteries is atherosclerosis [ath-air-oh-sklair-OH-sis]. *Athero* refers to the arteries and *sclerosis* means "hardening." Figure 10–5 shows what this disease does to a person's arteries.

Students may be more familiar with the term *arteriosclerosis,* which is a more general term that refers only to a thickening and hardening of the arterial walls. Atherosclerosis is one form of arteriosclerosis, characterized by the buildup of fatty deposits.



normal artery; muscular wall clear

some sclerosis; buildup of fatty tissue and calcium on inside wall

advanced buildup of calcium tissue; weakened arterial wall, rough on inside

Figure 10–5

✓ 10–7. How do you think an advanced condition of atherosclerosis affects blood flow?

10-7. An advanced condition of atherosclerosis slows down blood flow because the passageway is smaller. The walls are also less elastic, so blood pressure increases.

Both heart attack and stroke are usually a direct result of atherosclerosis. The rough surface of the wall in the diseased artery can cause blood clots to form. If a clot is large enough, it could block blood flow. If this happens in an artery supplying the heart muscle, the result could be a heart attack. If the artery supplies a part of the brain, the result could be a stroke.

For the most part, short of a heart attack or stroke, symptoms of atherosclerosis are not outwardly apparent. But a doctor may be able to detect the fat and calcium deposits in three ways:

1. Chest X rays may show deposits in large arteries.

2. Listening to the pulse in the carotid artery (a large artery in the neck) may reveal a "swishing" sound, indicating deposits.

3. A weak or missing pulse in the large artery in the groin may mean partial blockage from deposits.

The most effective treatment for atherosclerosis lies in a person's diet: Reduce intake of foods that are high in cholesterol and animal fat.

10-8. Heart attack and stroke are two most serious outcomes of atherosclerosis.

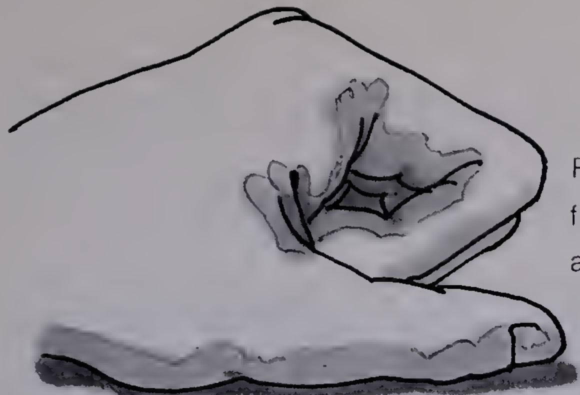
✓ 10–8. What are the two most serious outcomes of atherosclerosis?

HYPERTENSION

Another disease of the circulatory system is systemic hypertension, or high blood pressure. It is called *systemic* because it affects the whole system. High blood pressure is discussed in more detail in Activity 9.

You may want to mention here what is implied in Activity 9, that a constant state of emotional stress may lead to hypertension. This is the reason for a treatment based on rest and medication.

In most cases, hypertension shows no outward symptoms. The only sure way to tell whether you have it is to have your blood pressure measured. Treatment for hypertension is based on rest, medication, and diet control.



Rule of thumb
for identifying high blood pressure:
anything higher than 140/90.

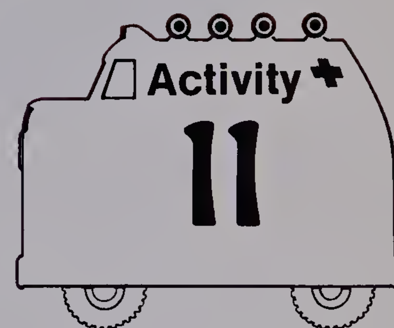
10-9. Answers will vary. (Range is from 100/60 to 135/90 for high school students.)

10-10. Both atherosclerosis and hypertension put a strain on the heart and vessels. In atherosclerosis, the heart has to pump harder to get the blood through the weakened, partially blocked vessels. In hypertension, the heart must likewise pump harder to get the blood through vessels that resist blood flow.

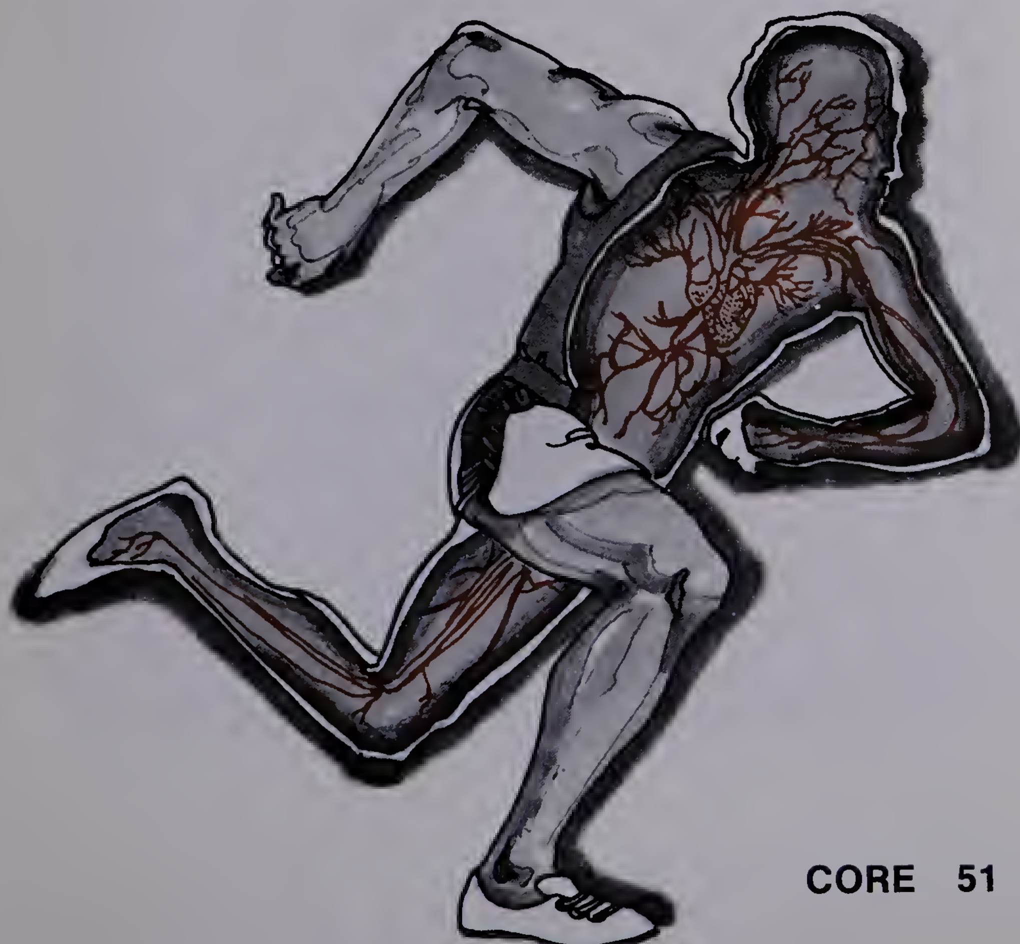
✓ 10–9. What is your blood pressure? (See Activity 9 to learn how to measure blood pressure.)

★ **10–10. How are atherosclerosis and hypertension alike?**

The Heart in Action



To stay alive, every living cell must have a continuous supply of blood. It is the heart that keeps blood moving through the body. It receives "used" blood, recycles it, and pumps out "fresh" blood.



ACTIVITY EMPHASIS: The heart consists of four chambers. The right side receives deoxygenated blood from the body and pumps it to the lungs; the left side receives oxygenated blood from the lungs and pumps it to the body. One-way valves direct blood flow through the heart.

MATERIALS PER STUDENT UNIT
- cassette tape for *Heart Attack*
- cassette player, preferably with headphones

Get the cassette tape for *Heart Attack* and listen to the band for Activity 11. As you listen, look at the illustrations in this activity. The tape and the pictures will give you all the information you need to answer the questions.

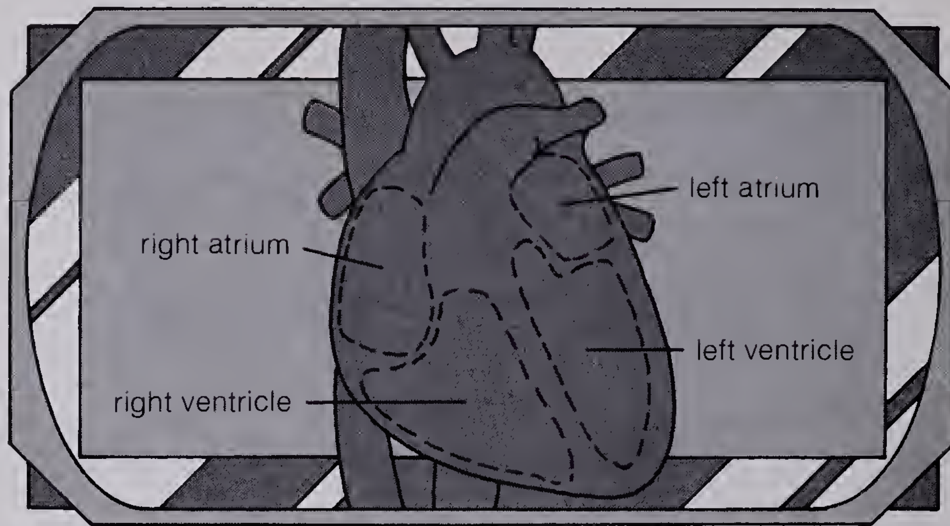


Figure 11–1

11-1. Four: right atrium, right ventricle, left atrium, left ventricle.

✓ 11–1. How many chambers are there in your heart? What are the names of the chambers?

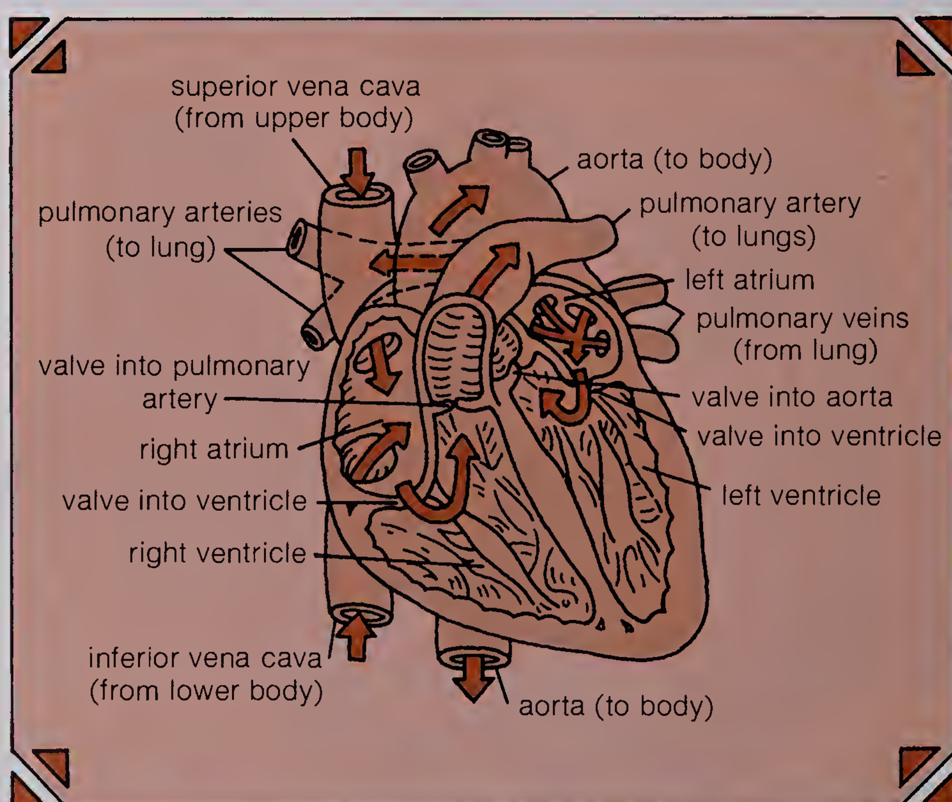


Figure 11–2

★ **11–2. Which chambers first receive blood coming into the heart?**

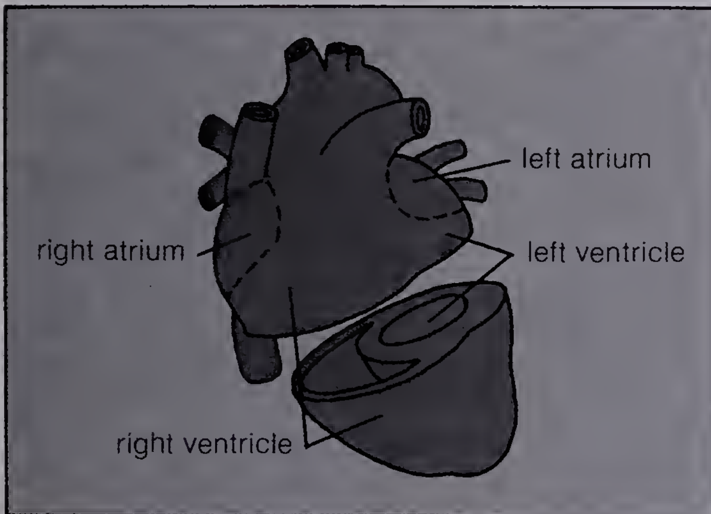
11-2. The atria.

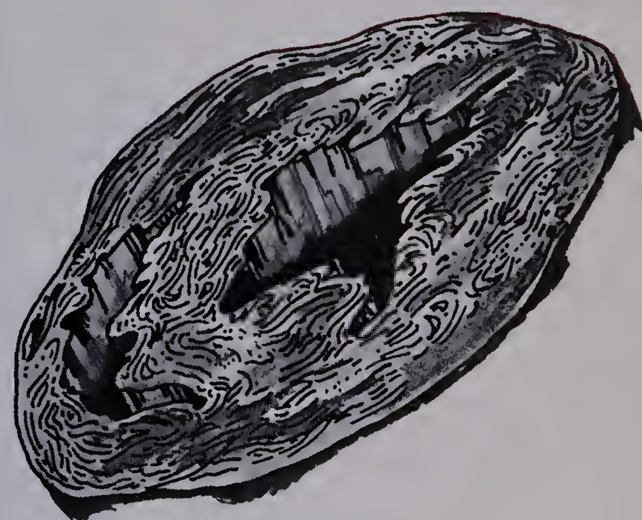
★ **11–3. Which chambers pump blood out of the heart?**

11-3. The ventricles.

★ **11–4. When the ventricles contract, why doesn't blood get pushed back into the atria instead of into the arteries?**

11-4. One-way valves between the atria and ventricles close when blood pushes against them in the wrong direction.





CROSS SECTION OF HEART THROUGH THE VENTRICLES

Figure 11–3 For interested students, Advanced Activity 14 goes into much greater detail on the heart's valves.

✔ 11–5. Why is the wall of the left ventricle much more muscular than the wall of the right ventricle?

11-5. The left ventricle must pump blood to all parts of the body, while the right ventricle pumps blood only to the nearby lungs.

✔ 11–6. Explain the "lub-dub" sound of the human heartbeat.

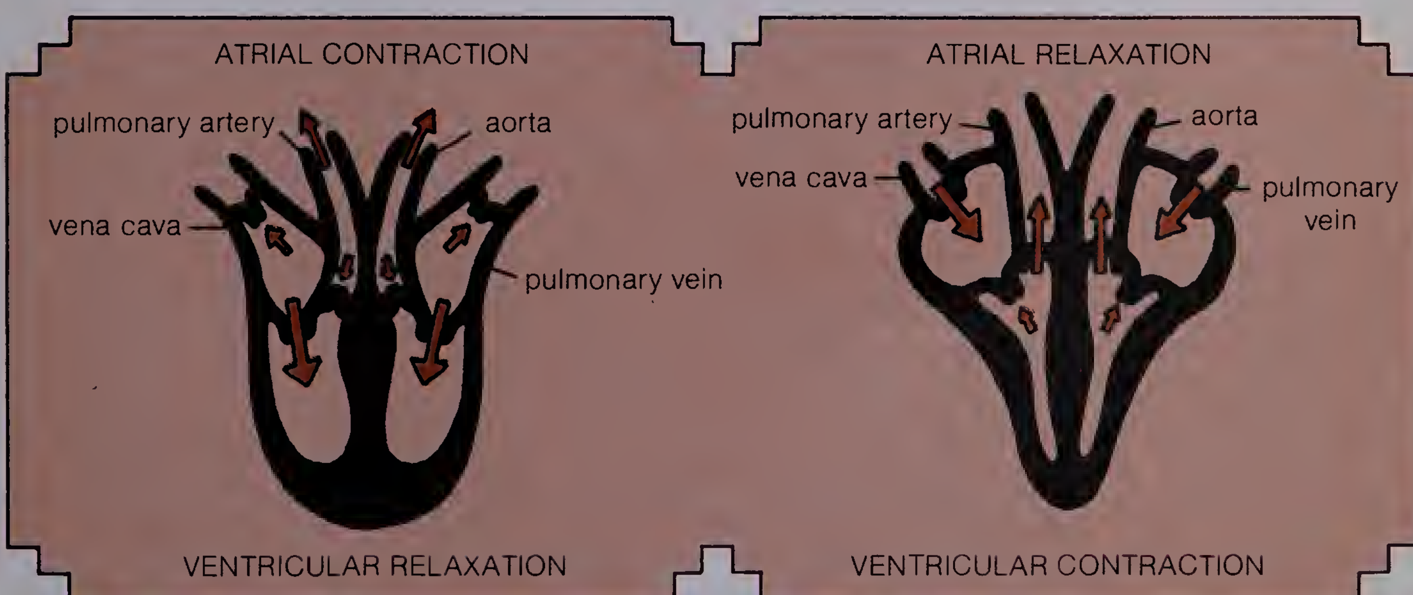


Figure 11–4

11-6. When the ventricles contract, the back pressure of blood closes the one-way valves between the atria and ventricles. When those valves shut, you hear a "lub" sound. When the ventricles relax, the valves between the arteries and ventricles close, producing a "dub" sound.

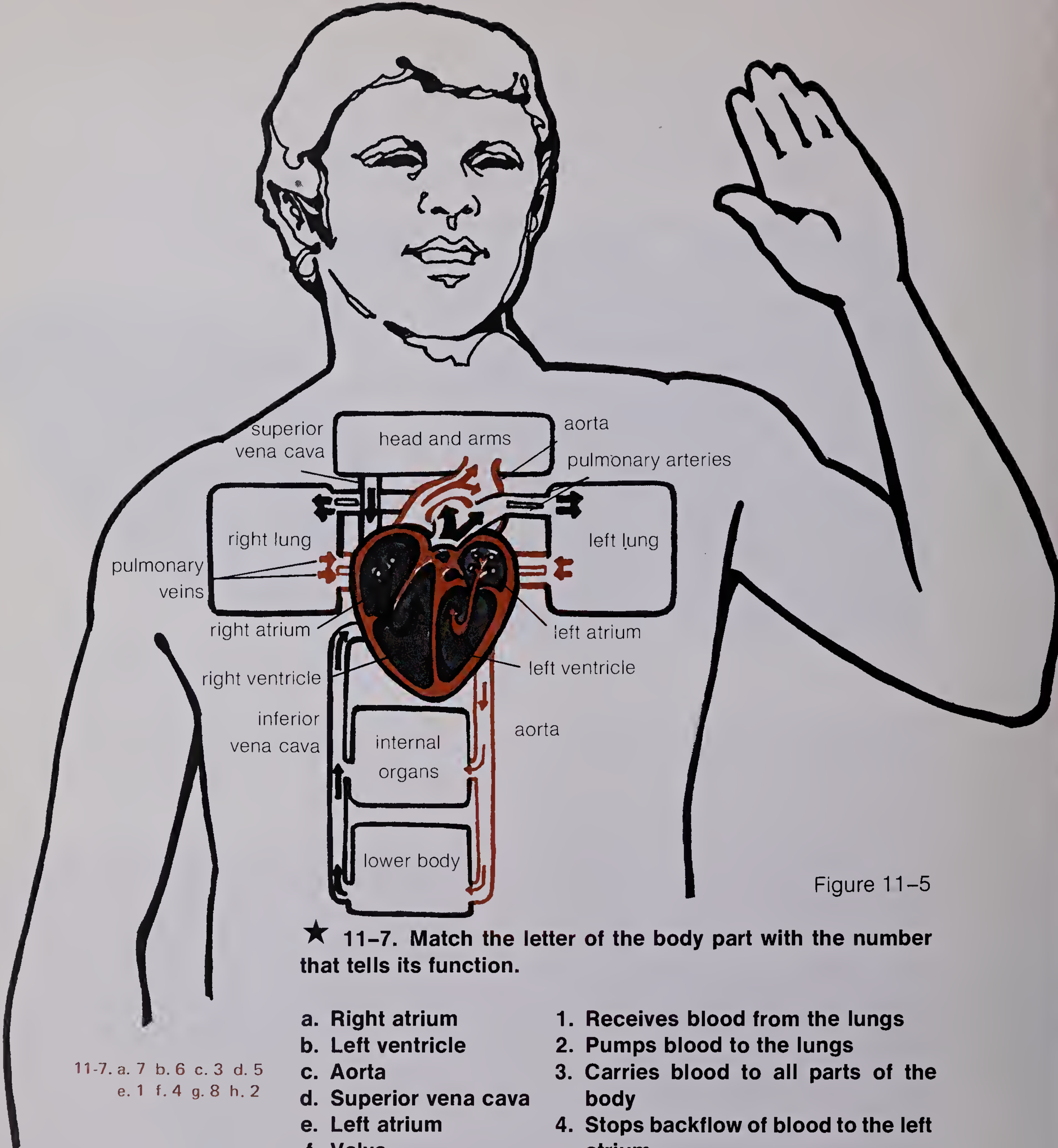


Figure 11–5

★ **11–7. Match the letter of the body part with the number that tells its function.**

a. Right atrium
b. Left ventricle
c. Aorta
d. Superior vena cava
e. Left atrium
f. Valve
g. Pulmonary vein
h. Right ventricle

1. Receives blood from the lungs
2. Pumps blood to the lungs
3. Carries blood to all parts of the body
4. Stops backflow of blood to the left atrium
5. Carries blood to the right atrium
6. Pumps blood into the aorta
7. Receives blood from all parts of the body
8. Carries blood to the left atrium

11-7. a. 7 b. 6 c. 3 d. 5 e. 1 f. 4 g. 8 h. 2

advanced

Activity 12 Planning

Activity 13 Page 56

Objective 16: Define diastolic and systolic blood pressures and describe their causes.

Sample Question: The term systolic pressure *refers to*

a. *the constant pressure of the vessel walls on the blood.*
b. *high blood pressure.*
c. *the extra pressure on vessel walls when the ventricles contract.*
d. *the pressure of the blood inside the heart.*

Activity 14 Page 59

Objective 17: Identify the location of each heart valve and describe how valves control the flow of blood through the heart.

Sample Question: When blood is pumped from the ventricles to the major arteries, which heart valves close?

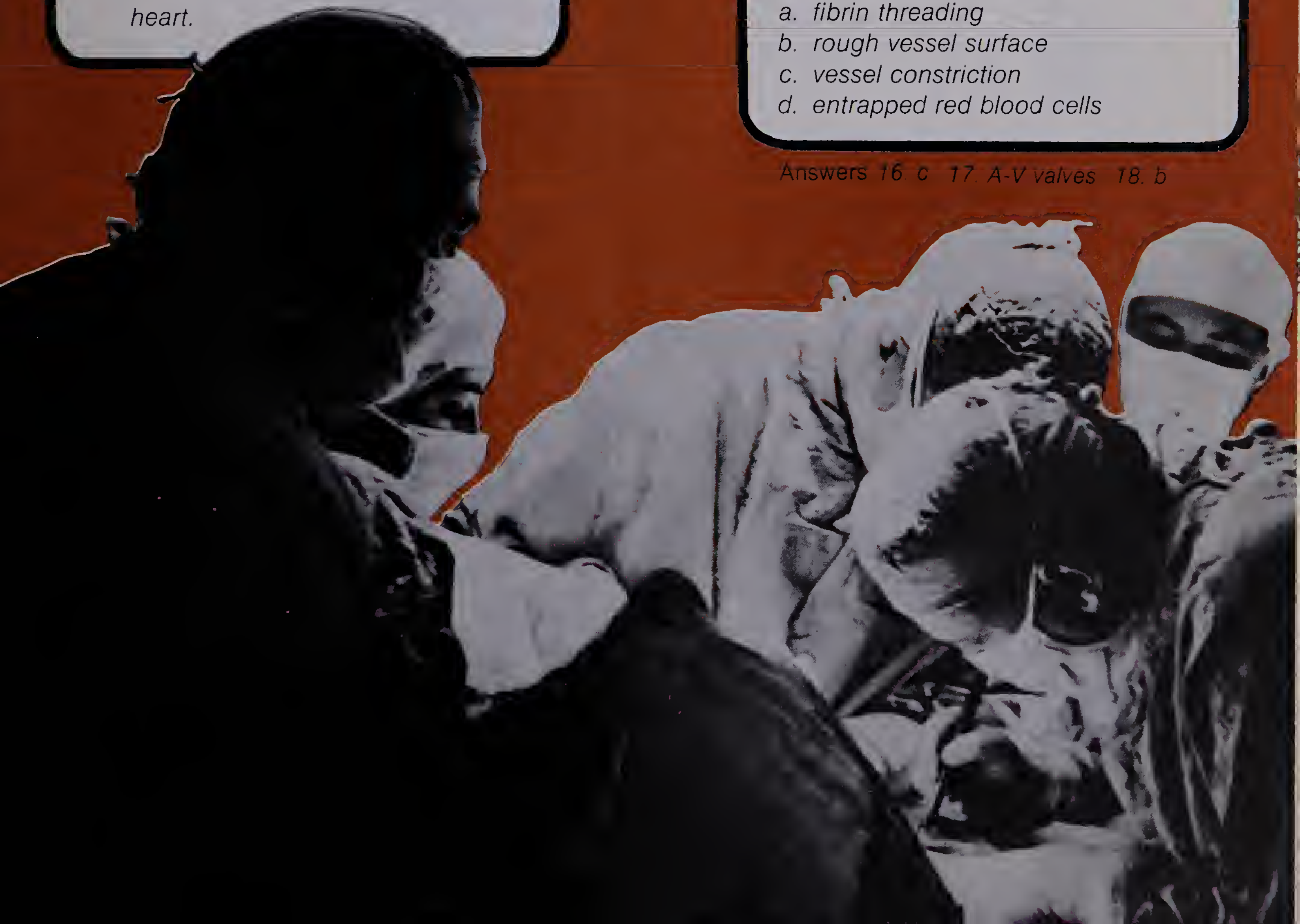
Activity 15 Page 61

Objective 18: Describe the process of blood clotting and explain why clotting is an important function of the blood.

Sample Question: What causes platelets to clump?

a. *fibrin threading*
b. *rough vessel surface*
c. *vessel constriction*
d. *entrapped red blood cells*

Answers *16. c 17. A-V valves 18. b*



Systolic and Diastolic Pressures

MATERIALS PER STUDENT UNIT
wide rubber band

ACTIVITY EMPHASIS: This activity distinguishes the difference between systolic and diastolic pressure.

Unless you cut yourself, your blood is always surrounded by walls because it travels within a closed system (simplified in Figure 13–1). Within this system, the blood is under constant pressure. It is squeezed out of a contracting heart; it is squeezed toward the capillaries by the elastic and muscular arterial walls; finally, it is squeezed back to the heart, mostly by the motion of nearby muscles.

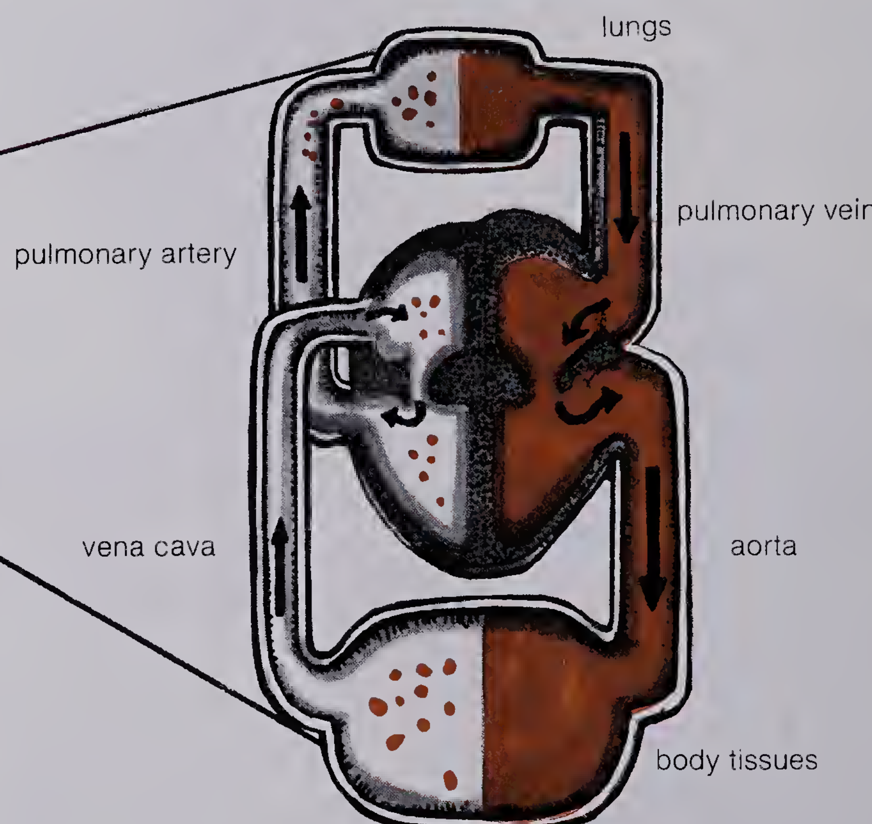
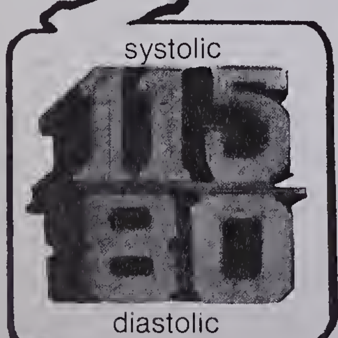


Figure 13–1

✓ 13–1. Suppose the blood got to the capillaries by only the push from the heart, that no further force were applied by the arterial walls. The blood would probably never reach the veins. Why not? (Hint: Consider the size and makeup of capillary walls.)



As you learned in the core, there are two levels of blood pressure, systolic and diastolic. When the heart beats, it is in the phase of systole; when the heart rests, it is in the phase of diastole.

13-1. The blood reaching the capillaries would be under low pressure. It would receive no further pressure in the capillaries because they have no muscle or elastic tissue.

★ **13-2. If the heart is resting during diastole, why is diastolic pressure not zero?**

✓ 13-3. When you take a sphygmomanometer reading for systolic pressure, what are you really measuring?

Don't worry if you had trouble with either of those questions. You'll come back to them later on with some more information.

Your whole circulatory system is elastic. To different degrees, the heart, veins, and arteries can all stretch. This elasticity enables the circulatory system to hold more blood than it could if all its parts were rigid.

13-2. Even in diastole, the blood is still moving in the vessels and is putting some pressure against the vessel walls.

13-3. The extra pressure on the vessels due to the contraction of the ventricles.

Get a wide rubber band. Think of it as a thin slice of blood vessel wall.

A. Insert your thumb and two or three fingers inside the band, but don't stretch the band yet.

Your fingers represent the blood inside the blood vessel. You can see, or feel, that the vessel wall isn't putting any pressure on what's inside it.

B. Now spread your fingers to simulate putting more blood into the vessel. Picture a bunch of fingers added to your own inside the band. This "extra blood" stretches the vessel wall.

13-4. The blood within the vessel gets squeezed. The wall is applying more pressure against the blood.

★ **13–4. How does stretching the wall of a blood vessel affect the blood within it?**

Your circulatory system contains enough blood to keep the vessel walls always slightly stretched. So there is always a certain amount of diastolic pressure.

13-5. Systolic pressure is higher because it includes the diastolic pressure plus the extra pressure due to the contraction of the ventricles.

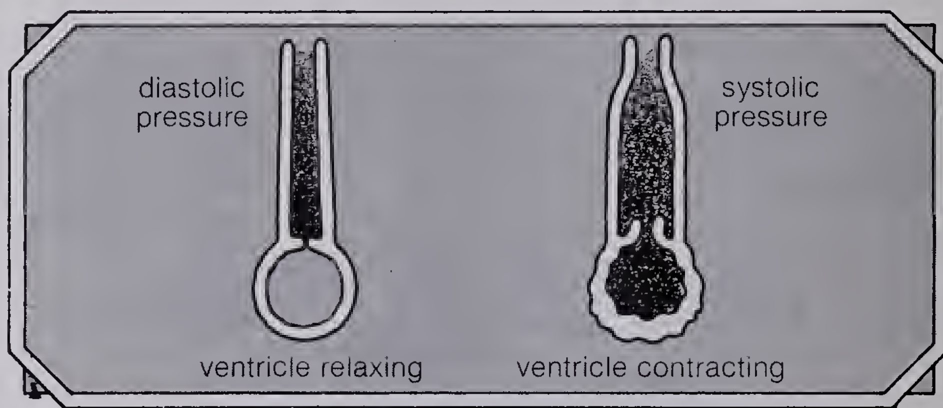
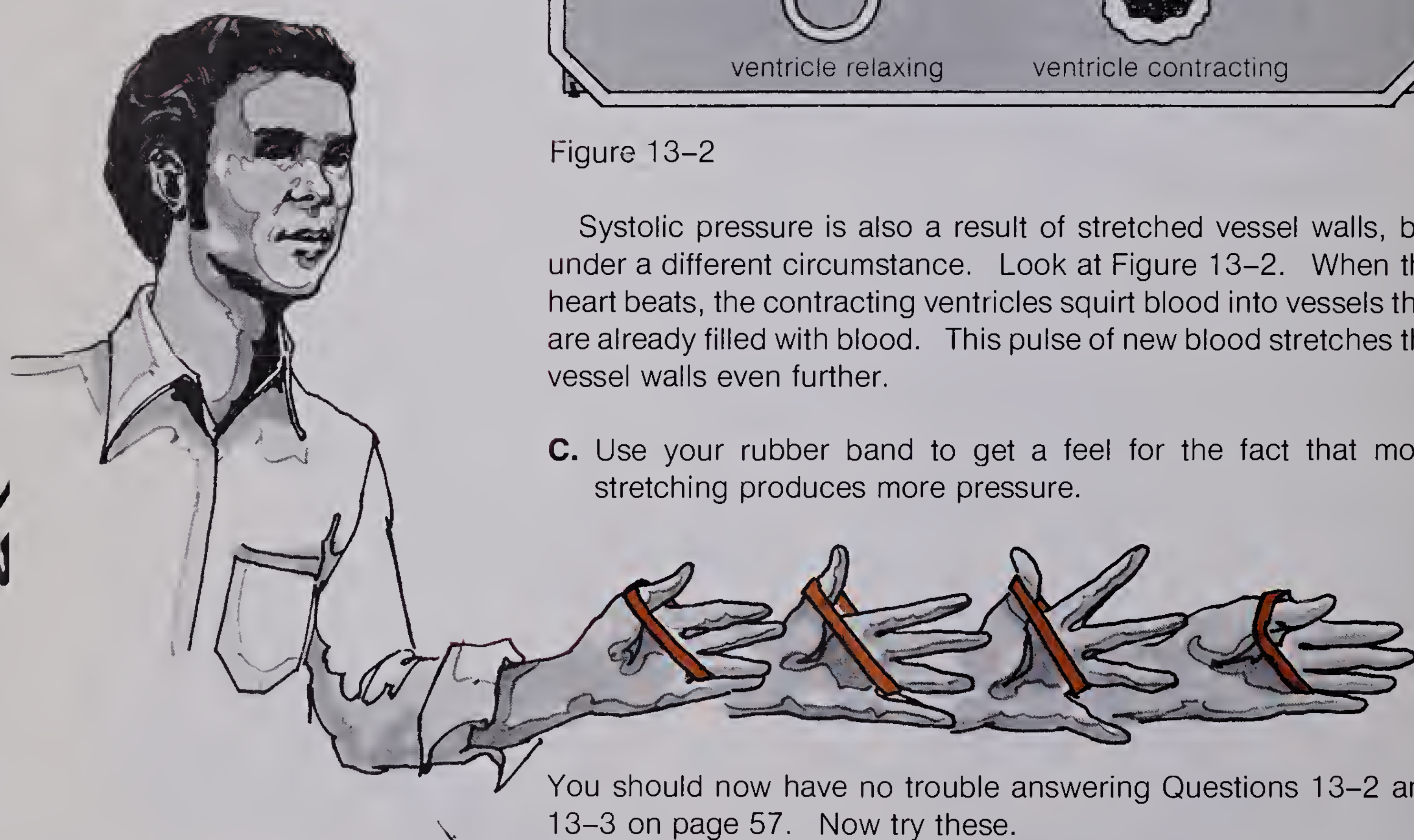


Figure 13–2

Systolic pressure is also a result of stretched vessel walls, but under a different circumstance. Look at Figure 13–2. When the heart beats, the contracting ventricles squirt blood into vessels that are already filled with blood. This pulse of new blood stretches the vessel walls even further.

C. Use your rubber band to get a feel for the fact that more stretching produces more pressure.



You should now have no trouble answering Questions 13–2 and 13–3 on page 57. Now try these.

★ **13–5. Why is systolic pressure higher than diastolic pressure?**

✔ 13–6. Based on what you've learned in this activity, describe how atherosclerosis causes high blood pressure.

✔ 13–7. When would the diastolic and systolic pressures both be zero?

13-6. In atherosclerosis, the vessel walls are weakened by the build-up of deposits such that the walls don't stretch and spring back normally. This lack of elasticity causes higher pressure against the blood as it travels through the narrowed vessels.

13-7. At death.

ACTIVITY EMPHASIS: The passage of blood through the heart is controlled by one-way valves. The valves function by responding to differences in blood pressure within the heart chambers and between the ventricles and the two arteries, the aorta and pulmonary.

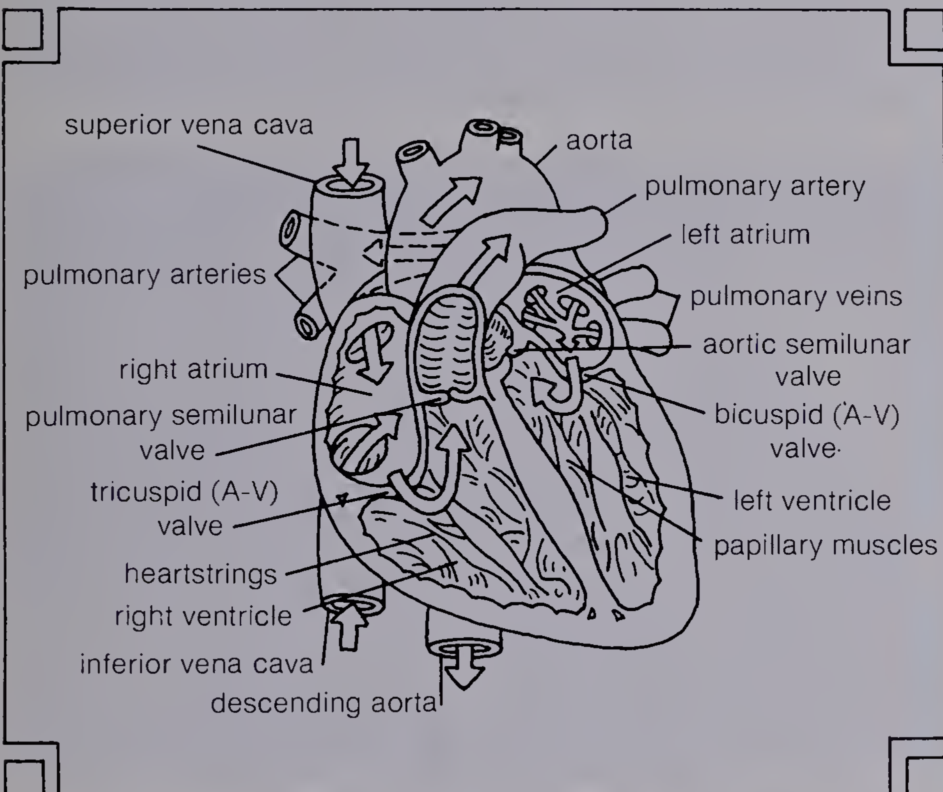
The Heart's Valves

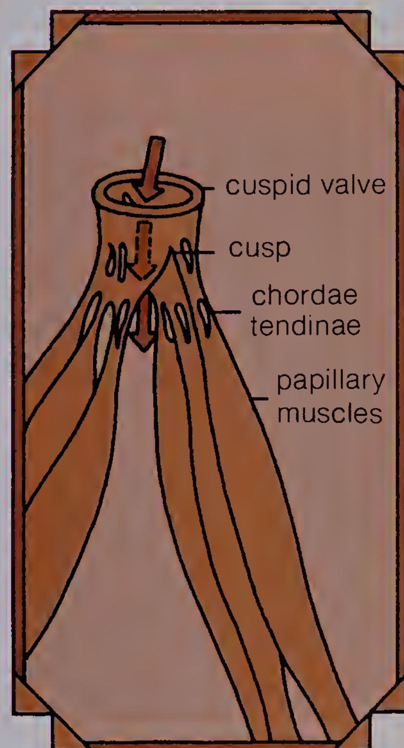
Activity 14

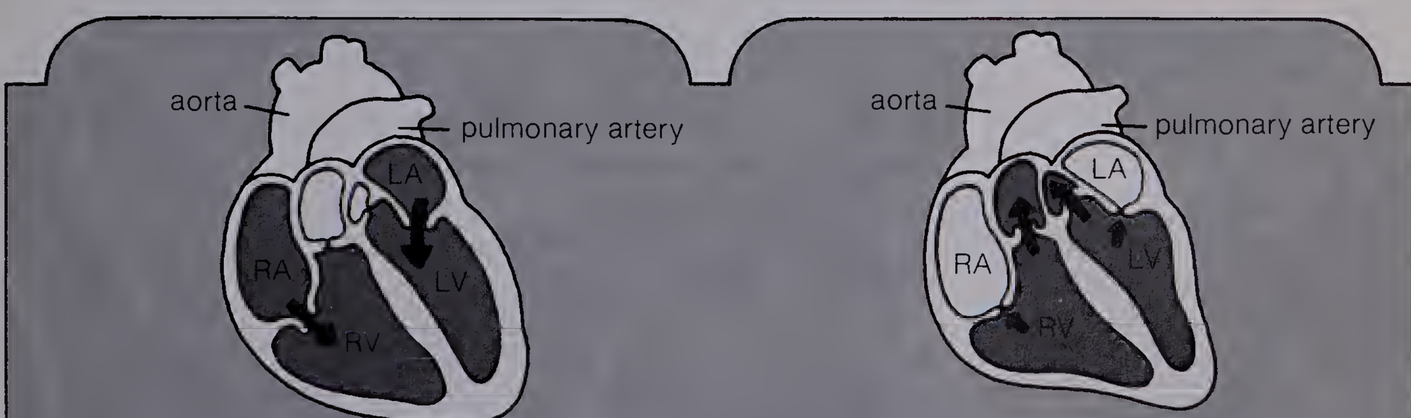
MATERIALS PER STUDENT UNIT

cassette tape for *Heart Attack;* cassette player, preferably with headphones

The valves in your heart are essential to its pumping action. The tape band for Activity 14 goes into some detail about your heart's valves and how they function. As you listen, study the illustrations included here and on the next page. Try to associate the parts with their names. Answer the questions when you're ready. You may want to listen to the tape a second time to check your answers.

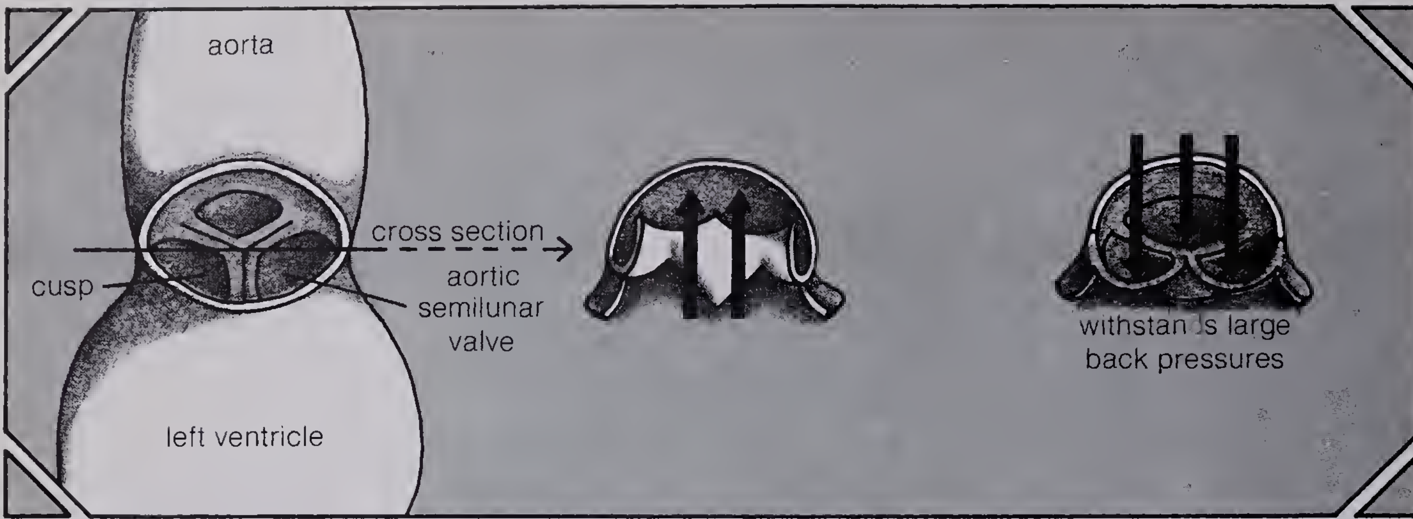


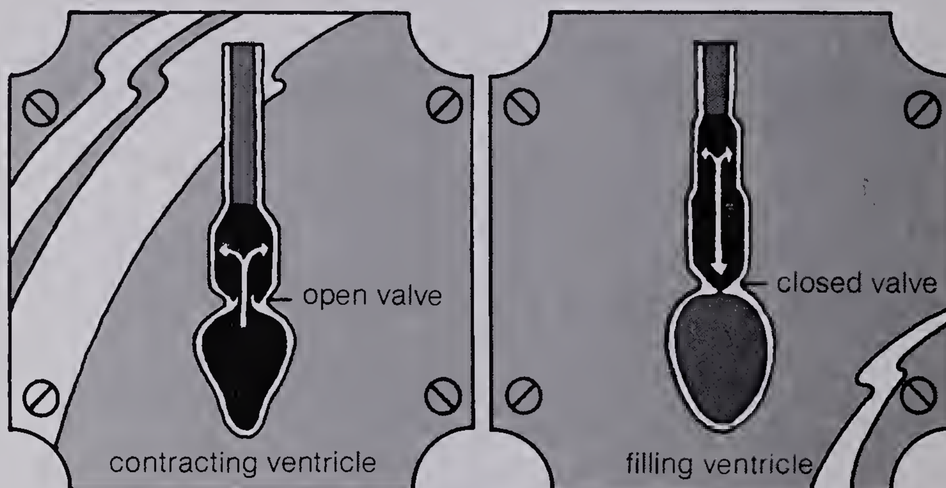




Ventricles relax.
Pressure in ventricles falls.
Higher pressure in atria forces the A-V valves open.

Ventricles contract.
Higher pressure in ventricles closes A-V valves.
Heartstrings keep cusps from flipping into atria.





★ **14–1. What causes heart valves to open and close?**

14-1. The direction of blood flow, determined by blood pressure differences on the two sides of the valve.

★ **14–2. When the ventricles contract, why don't the A-V, or cuspid, valves flip backward into the atria?**

14-2. The heartstrings, which attach the cusps to the papillary muscles, keep the cusps from flipping backward into the atria.

✔ 14–3. Why are the A-V valves called *tricuspid* and *bicuspid?*

14-3. The *tri*cuspid A-V valve is made of *three* cusps; the *bi*cuspid A-V valve is made of *two* cusps.

★ **14–4. What is the main functional difference between the A-V valves and the semilunar valves?**

14-4. The semilunar valves are able to withstand much greater pressure differences than can the A-V valves.

✔ 14–5. Which valve in the heart must withstand the greatest backflow pressure?

14-5. The semilunar valve between the left ventricle and the aorta.

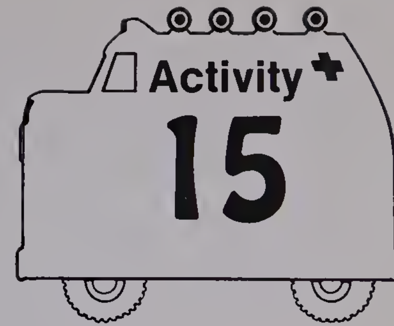
✔ 14–6. When the atria contract, what reduces the backflow of blood into the veins that enter the atria?

14-6. Contraction of muscular rings around the veins near where the veins enter the atria.

✔ 14–7. Name two kinds of things that may account for damage to heart valves.

14-7. Disease and birth defects.

Blood Clots and Broken Vessels



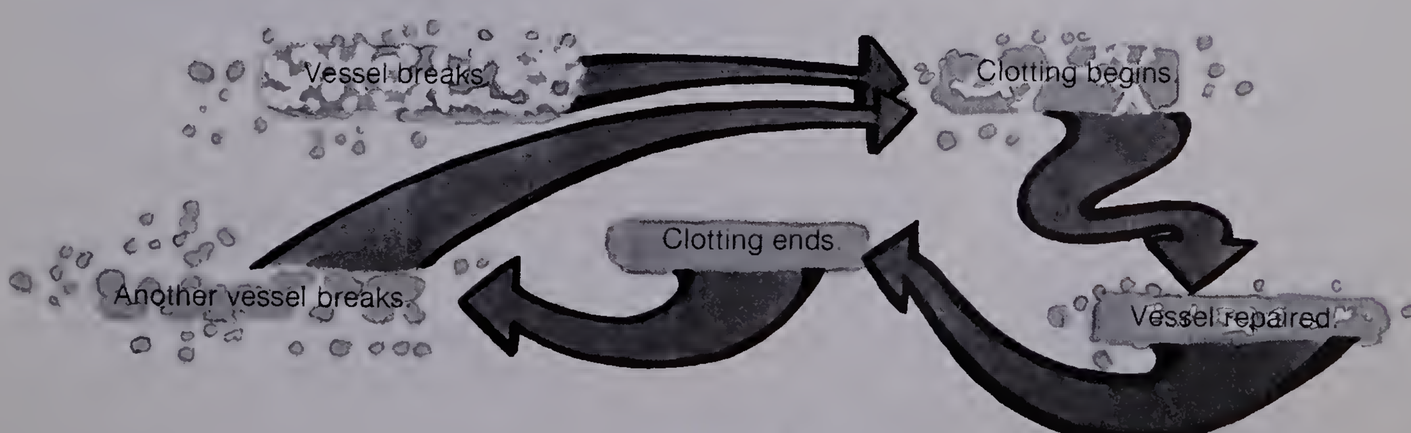
MATERIALS PER STUDENT UNIT

None.

To survive, your body has to be able to stop blood loss when vessels rupture. Because of their fragile nature, capillaries and small arteries are continually breaking within the body. And these as well as the larger vessels may be cut by any number of accidents, from tiny "paper cuts" to major injuries sustained in a car crash. Even the most minor of vessel cuts or breakages could result in a person bleeding to death unless the holes get plugged.

ACTIVITY EMPHASIS: Blood clotting mechanism as example of feedback system. Process initiated by rough vessel surface; vessel constricts; platelets clump, burst open; fibrin network develops; red cells are trapped and clot is formed.

The clotting mechanism is an example of a feedback system in the body. The clotting process is set into motion by an abnormal condition within the blood vessel. When the bleeding has stopped, the clotting mechanism responds by shutting itself off.



15-1. Clotting would spread throughout the circulatory system.

✓ 15–1. Suppose clotting were not part of a feedback system. What would probably happen once clotting started within a vessel?

Although much remains to be learned about the clotting mechanism, research has uncovered a great deal in recent years. Over ten different blood factors are now associated with the clotting process. Through research on the chemical interactions of those various factors, scientists have defined a complex series of events that lead to the final repair of a broken vessel. Figure 15–1 gives a most simplified picture of what happens when a vessel is damaged.

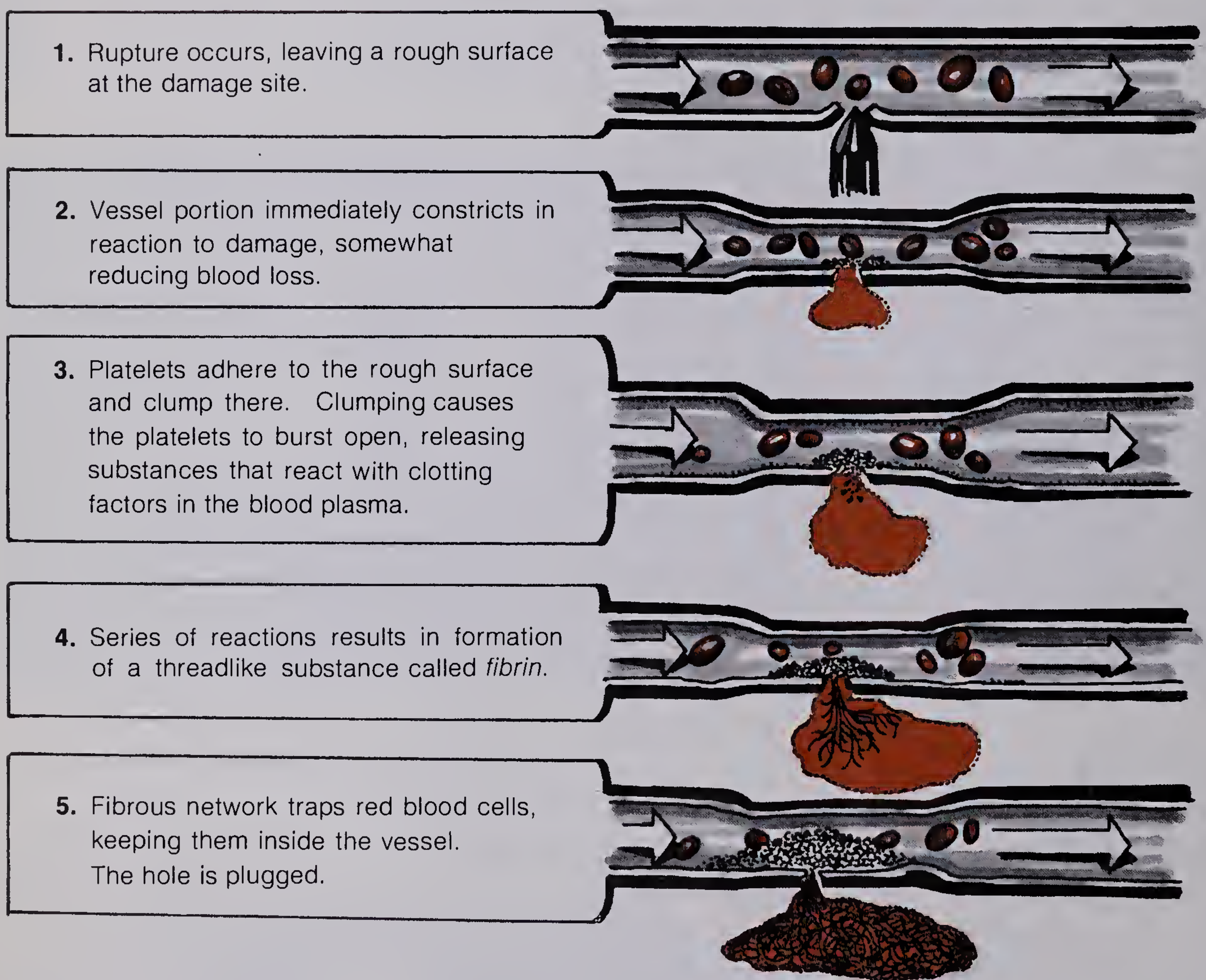


Figure 15–1

15-2. A rough vessel surface causes platelets to clump. Clumping causes the platelets to burst open.

15-3. Clots do spread down a vessel, but only until the vessel intersects with another vessel. The faster flow of blood in that undamaged vessel sweeps platelets away before they can clump.

✓ 15–2. What causes blood platelets to clump? To burst open?

✓ 15–3. What do you think prevents a clot from spreading down the vessel?

Answering that last question takes a little more knowledge about the clotting process. Look at Figure 15–2. A clot may indeed continue to build along the wall of the damaged vessel. But it soon reaches an intersection with another vessel. The faster flow of blood in the undamaged vessel sweeps its platelets past the clot area before they can clump.

There is also a feedback mechanism at work in the body to dissolve blood clots that have done their job.

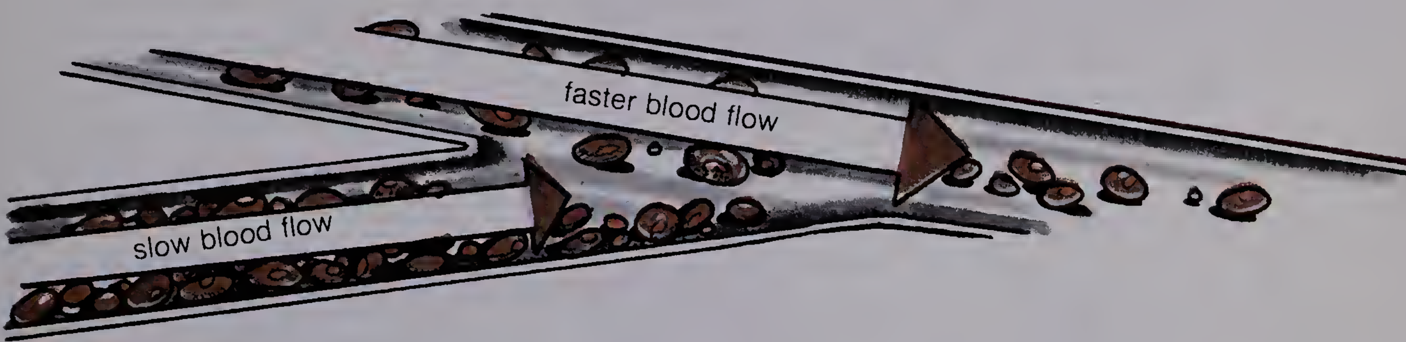


Figure 15–2

★ 15–4. In your own words, describe the process of clotting.

15-4. Student should include this order of events: rough vessel surface occurs, vessel constricts, platelets clump and burst open, fibrin is produced, red blood cells are trapped.

★ 15–5. Anticoagulant drugs are drugs that reduce the clotting function. Why do you think doctors often use anticoagulants with patients who have serious heart conditions?

15-5. Patients with serious heart conditions will have some amount of vessel damage because of their illness. Anticoagulants reduce the chances that blood will clot in those damaged vessels and block blood flow to the heart.

When a clot blocks an artery that supplies the heart or brain, a heart attack or stroke may occur. Such a clot may have traveled from a distant part of the circulatory system, perhaps from the leg. When a clot develops in a larger vessel, where blood flow is relatively fast, the clot can be ripped loose by the blood and carried toward the heart. Moving clots, called *emboli*, can be deadly.

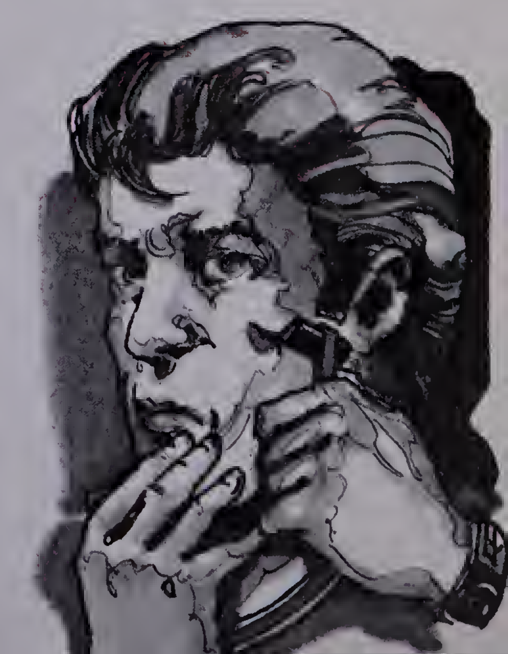
15-6. Yes. The doctors would try to dissolve the clots in the leg to prevent occurrence of emboli.

✔ 15–6. People are sometimes hospitalized because of clots in the leg. Might such people be given anticoagulants? Explain.

The clotting mechanism, like all body systems, can go wrong. In some people, the mechanism may overact, forming clots at the slightest provocation. In others, the mechanism may underact.

Hemophilia is a disease in which the ability to clot is impaired because one or more of the clotting factors are missing from an individual's blood. Clots may take hours or even days to form. The usual treatment for hemophilia involves plasma transfusions containing the missing factor or factors.

Hemophiliacs must be very careful to avoid injuries. Just think for a minute how many cuts and bruises the normal person takes for granted that a hemophiliac cannot.



There are actually three mechanisms in the prevention of blood loss: vessel constriction, platelet aggregation, and blood clotting. Defects may occur in each mechanism, causing over- or underactivity.

excursion

Activity 16 Planning

Vital Signs of Life
Activity 17 Page 65

Sometimes it's difficult to determine whether a person is dead or just out cold. This activity shows you how to tell the difference.

Looking at Blood Cells
Activity 18 Page 68

You have probably given a drop of blood from your finger during a medical checkup. Doctors can learn many things about your health by examining this tiny drop. In this activity, you look at a drop of your own blood and see what the doctors see.

Locating Your Vein Valves
Activity 19 Page 72

Small valves in your veins prevent blood from flowing in the wrong direction in your body. You can locate these valves in your own veins. You can even measure the distance from one valve to another and see the blood moving in your veins. You'll find out how in this activity.

Preventing Blood Loss from Wounds
Activity 20 Page 75

Platelets in your blood work to prevent blood loss when you injure yourself. But there are some things you can do to help. Find out the safest ways to prevent blood loss in this activity.

ACTIVITY EMPHASIS: Vital life signs which can be readily checked are the presence or absence of breathing, condition of the carotid pulse, and dilation of the pupil of the eye.

Vital Signs of Life

Activity 17

You're walking to your next class chatting with a friend. Suddenly the girl walking ahead of you stops short. She clutches her chest, stumbles to the wall, and collapses. "I'll get help," your friend cries. "Check if she's all right. But don't move her, please!"

You rush to the girl's side. There's no time to be nervous. You want to help. What should you do?

Before doing anything, find out the student's condition. Is she breathing? Is her heart working? These are the vital signs of life.

MATERIALS PER STUDENT UNIT
None.

17-1. Look for chest motion; listen for movement of air around the nose and mouth; feel for air moving around nose and mouth area.

★ **17-1. How would you find out whether the girl was still breathing?**

★ **17-2. How would you check to see if her heart was still beating?** 17-2. Check for pulse or listen for heartbeat.

To check breathing see if the chest is moving. This is a good sign. Sometimes, however, the chest may appear quiet even during breathing. Listen for the sounds of breathing. Or feel for movement of air around the mouth and nose. If you feel air circulating, you know the person is alive.

Figure 17–1

Checking for heartbeat is not as simple. You can't always hear the heartbeat by listening at the chest. Clothing can muffle the sound. Feeling for pulse is the best way to tell if the heart is beating. Try it on yourself.

With your fingertips, press along your neck below the jaw. Move your fingers slightly until you feel the throb of your pulse.

This throb is caused by blood pulsating through the carotid artery. It is a stronger pulse than the one you feel in your wrist.

Find the pulse in the carotid artery of one or two classmates. You will then be able to locate the pulse of anyone in an emergency.

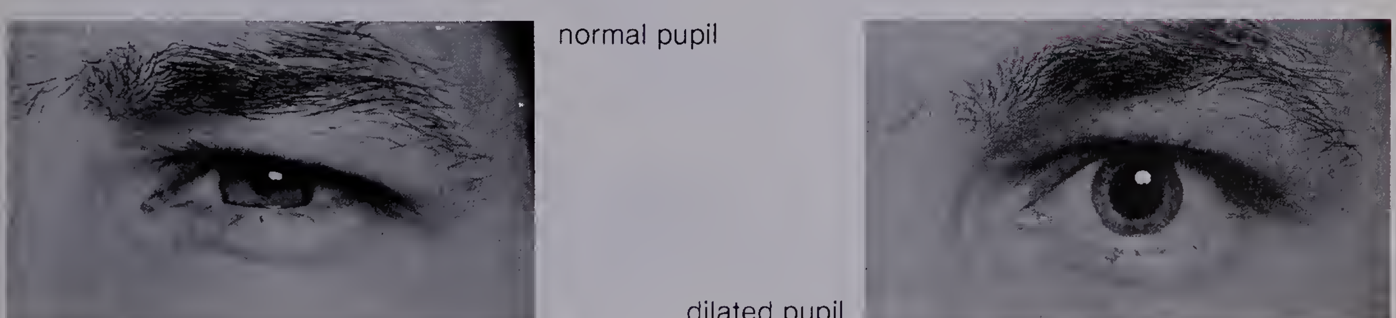
17–3. Why do you think the pulse in the carotid artery is stronger than the pulse in the wrist?

17-3. The carotid artery is closer to the heart. Also, more blood goes through the carotid artery to supply the brain than goes through arteries that supply the fingers.

Suppose you found no breathing, no heartbeat, and no pulse. There is one final check. Look at the student's eyes. See what happens to the center part — the pupil — when exposed to light. Normally, the pupil becomes smaller when light shines on it. Observe how this works with a classmate.

Have a classmate close his or her eyes and cover them with the hands for about 30 seconds. Then have your classmate open his or her eyes. Watch the pupils closely. See how they change size.

If the pupils of the collapsed person remain large, or dilated, when you open her eyes, she is in serious danger. Oxygen is not getting to the brain. The person is probably suffering from heart failure, a back injury, or shock. Look at the normal and dilated pupils in Figure 17–2.

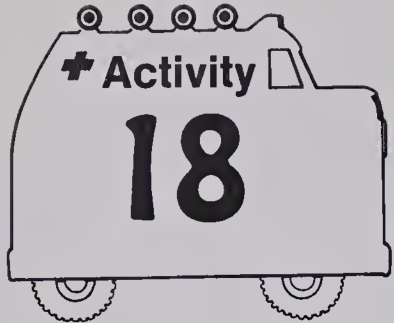


normal pupil

dilated pupil

Figure 17–2

Learning the condition of a collapsed person is the first step in giving first aid. But if you have not had first-aid training, do nothing more. Wait for a physician or trained person to arrive. If you want to learn how to give first aid, your local Red Cross center will help.



Looking at Blood Cells

ACTIVITY EMPHASIS: Students have the opportunity to take a sample of their own blood and examine it under a microscope. If students are prohibited by regulations from taking blood samples, they should simply read the activity and/or choose another excursion.

The activity should be done while sitting down to avoid possible falling should a shock reaction occur and cause fainting. If a student should become nauseated or faint during the activity, passing out can be avoided by placing the head between the knees while sitting.

In this activity you will have to prick your finger to get a sample of blood. Your school may require your parents' permission to do this activity. So check with your teacher before you start. If you're all set, gather together these items:

- isopropyl alcohol
- sterile cotton
- wrapped disposable lancet
- 2 clean slides
- toothpick
- beaker
- Wright's stain
- medicine dropper
- distilled water
- microscope

MATERIALS PER STUDENT UNIT

alcohol, isopropyl, 70%
cotton balls, sterile
lancet, sterile blood, disposable
2 slides, microscope
toothpick
beaker
Wright's stain
dropper, medicine
water, distilled
microscope, compound
Resource Unit 3

Have *Resource Unit 3* available to aid in the use of the microscope.

You will have to know how to use a microscope for this activity. If you need help, see *Resource Unit 3* before going on.

IMPORTANT: Read through all the steps (Steps A through J) before you begin.

✓ 18–1. Why should you clean your finger before pricking it? After pricking it? 18-1. To avoid any danger of infection.

Students who plan to do Activities 18 and 19 should be reassured that these activities are not dangerous. However, inform students of certain safety precautions, given as annotations for each of these activities.

The finger from which blood is drawn should be cleaned thoroughly with 70% alcohol *before* and *after* sampling.

A. Pour isopropyl alcohol on some cotton. Clean your little finger thoroughly with the alcohol.

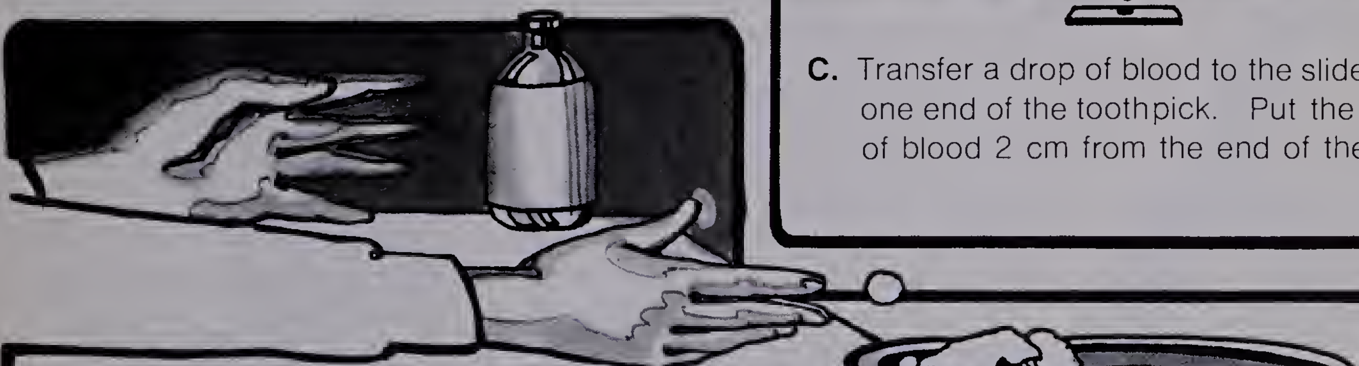
B. Use only an individually wrapped, sterile lancet to prick your finger. Do not use any other object. Press your thumb of the same hand against the tip of your small finger. Holding the lancet firmly, quickly prick the tip of your finger.

CAUTION

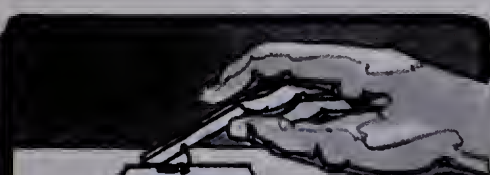
A new, sterile lancet must be used *each time.*

Throw the lancet away after use. Do not reuse it, even on yourself.

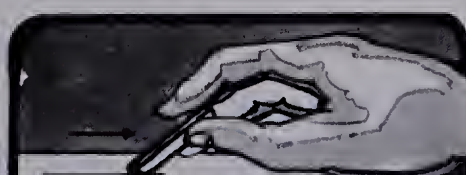
C. Transfer a drop of blood to the slide with one end of the toothpick. Put the drop of blood 2 cm from the end of the slide.



D. Throw away the used toothpick. Then clean your little finger again with sterile cotton dipped in isopropyl alcohol.



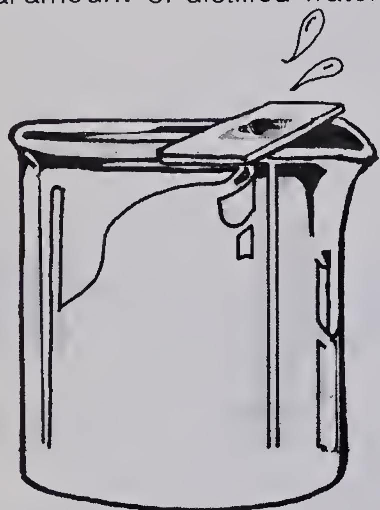
E. Hold a second slide at an angle of about 30 degrees so that one end touches the slide containing the blood.

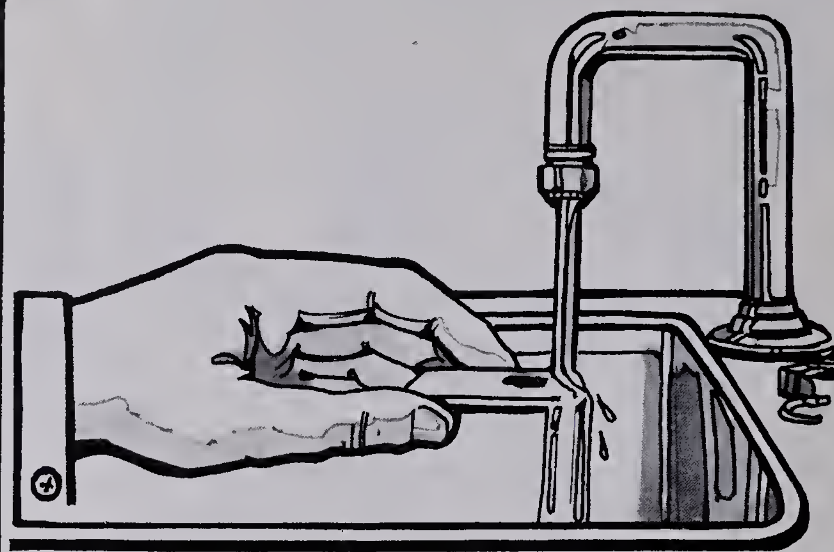


F. Pull the top slide over the drop of blood so that the blood spreads out between the two slides.

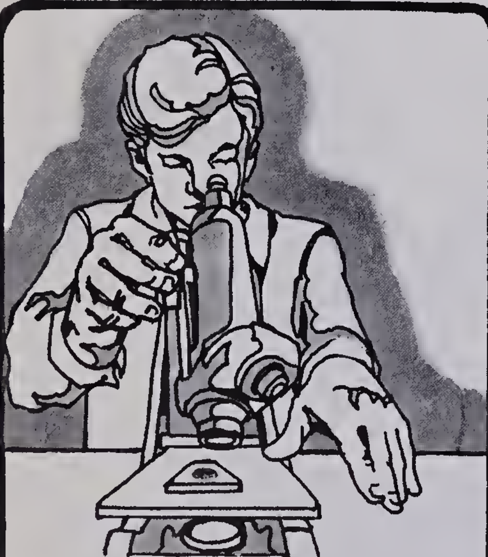
G. Quickly move the top slide in the opposite direction, making a thin film of blood. Remove the top slide. The film should be thin, without wavy lines or blotches. Let the film dry a few minutes.

H. Now stain the slide. Place the slide across a beaker in a sink. Cover the blood film with 2 or 3 drops of Wright's stain. Leave the stain on the blood for 1 minute. Then add an equal amount of distilled water.





I. Let the mixture of stain and water set on the slide for 3 minutes. Then rinse the slide under running tap water. Don't worry, the stained cells won't wash off.



J. Dry the slide in the air. Then look at it under the microscope — first under low power, then under high power. Make a sketch of what you see.

You should be able to see many red blood cells under the microscope. They look pale pink. White blood cells are larger than red cells. But they are harder to find because there are far fewer white cells than red cells. (Remember there are 500 to 1000 red cells for every white cell!) You'll probably have to move your slide around to locate a white blood cell.

A white blood cell has a structure in the center called a *nucleus*. The nucleus should appear quite dark, almost purple. Surrounding the nucleus is a material called *cytoplasm*. The cytoplasm will stain deep blue, bright red, or pale pink, depending upon the kind of white blood cell. Figure 18–1 shows the components you will find in a drop of blood. Compare your sketch to Figure 18–1.

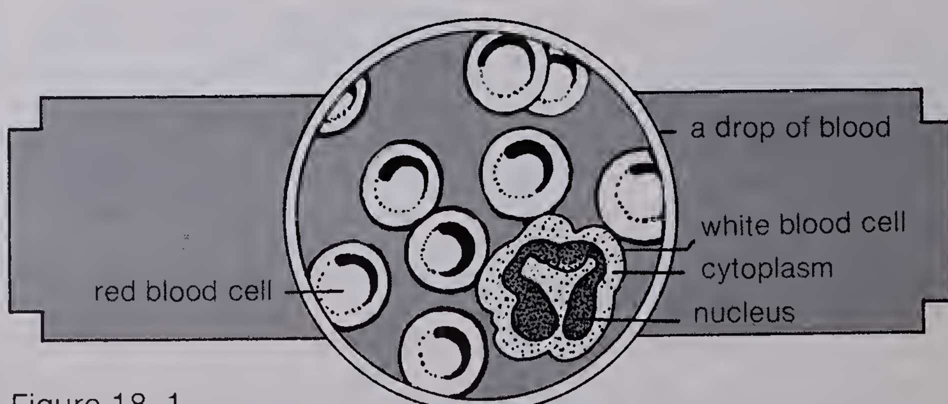


Figure 18–1

There are several kinds of white blood cells. Figure 18–2 shows the different kinds of white blood cells and how they should appear. Don't worry if you can't tell one kind of white cell from another on your slide. It isn't always very easy to tell which is which.

KINDS OF WHITE BLOOD CELLS

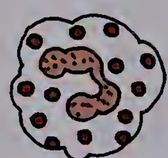
WHITE CELLS (LEUCOCYTES)	APPEARANCE	NUCLEUS	CYTOPLASM	NORMAL % IN BLOOD
Neutrophils		Lobe shaped, with grains	Small pink grains	60–65
Eosinophils		Lobe shaped, blue grains	Large red grains	2–4
Basophils		Lobe shaped, dark blue grains	Large purple grains	0.5–1
Lymphocytes		Purple, solid shape	Light blue, few or no grains	20–30
Monocytes		Purple, usually solid, may have 2 lobes	Light blue	3–8

Figure 18–2

✔ 18–2. What do you think is the purpose of Wright's stain?

★ **18–3. Why are white cells harder to find than red cells?**

18-2. Wright's stain colors the white blood cells, making them more readily visible.

18-3. There are far fewer white cells than red cells in a drop of blood.

Activity 19

Locating Your Vein Valves

ACTIVITY EMPHASIS: Students locate the position of vein valves in one of their limbs. This activity should be done while sitting down to avoid the danger of falling should a shock reaction occur and cause fainting. If students become nauseated or faint during the activities, passing out can be avoided by placing the head between the knees while sitting.

Your veins carry the blood to your heart. The blood moves "one way" only. What keeps the blood from flowing backwards? Your veins have valves — like those in a pipeline. These valves keep your blood flowing in the right direction. Find your own vein valves in this activity. You will need the following:

a partner
handkerchief or cloth

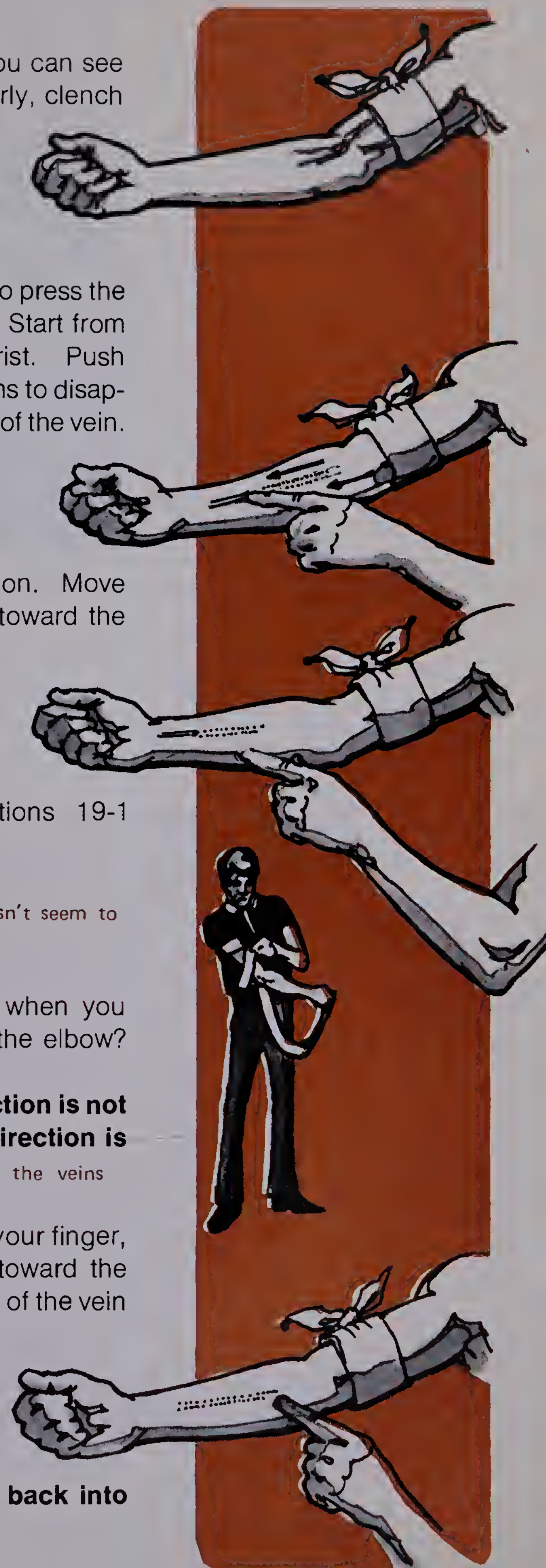
MATERIALS PER STUDENT UNIT
handkerchief or cloth

IMPORTANT: Read all the steps (Steps A through F) before starting the activity.

A. Have your partner tie a handkerchief snugly around your upper arm. This will act as a constricting band. It will slow or stop the supply of blood. The band should *not* be tight!

CAUTION

Don't leave the band on for more than two minutes!



B. Let your arm hang down. Turn up your palm so you can see the veins in your arm. If you cannot see them clearly, clench your fist several times.

C. Pick one of the larger veins. With your fingertip, try to press the blood out of the vein in the direction of your wrist. Start from the elbow and move the fingertip toward the wrist. Push slowly. Stop when you see that part of the vein seems to disappear or collapse. This means you have emptied part of the vein.

D. Now try to do the same thing in the opposite direction. Move your fingertips along the same vein from the wrist toward the elbow.

E. Release the constricting band. Answer Questions 19-1 and 19-2.

19-1. When the finger is moved toward the elbow, the vein doesn't seem to collapse as it does when the finger is moved toward the wrist.

✔ 19–1. What differences did you see in the vein when you moved your finger toward the wrist and then toward the elbow?

★ **19–2. Blood pressed out of the vein in one direction is not replaced. But blood pressed out in the opposite direction is replaced. Why does this happen?** 19.2. The valves in the veins allow the blood to flow in only one direction.

F. Put the constricting band on your arm again. With your finger, again apply pressure to the vein from the elbow toward the wrist. Release your finger. Watch carefully the part of the vein that has been emptied of blood.

19-3. Blood moves away from the wrist. This happens because the blood in veins moves toward the heart.

★ **19–3. From which direction does blood move back into the vein? Explain why this happens.**

Have students draw an analogy between the activity they have done and the work of Harvey.

You have just walked in the footsteps of a great English physician, William Harvey, who lived more than 300 years ago. Harvey startled the medical world in 1628 when he announced his theory about how blood circulates. Until then, scientists believed that the blood ebbed and flowed like a tide. The drawings below and the text are taken from Harvey's notebook.

Let an arm be tied above the elbow . . . In the course of the veins, certain large knots on elevations (B,C,D,E,F) will be perceived . . . ; these are all formed by valves. If you press the blood [through] . . . a valve, from H to O (Figure 2), you will see no influx of blood . . . ; yet will the vessel continue sufficiently distended above the valve (O,G). If you now apply a finger of the other hand upon the distended part of the vein above the valve O (Figure 3), and press downwards, you will find that you cannot force the blood through or beyond the valve. If you press at one part in the course of a vein with the point of a finger (Figure 4) and then with another finger streak the blood upwards beyond the next valve (N), you will perceive that this portion of the vein continues empty (L,N). That blood in the veins therefore proceeds . . . appears most obviously.

— William Harvey

Harvey could not explain how the blood got from the arteries into the veins. It remained for other scientists, using microscopes not available to Harvey, to discover the capillaries.

ACTIVITY EMPHASIS: Blood loss from a wound can be prevented, or at least reduced, by the use of pressure on the wound or at one of several pressure points. Use of a tourniquet is discouraged.

Preventing Blood Loss from Wounds

Activity 20

MATERIALS PER STUDENT UNIT
None.

If you lose too much blood from a wound or from internal bleeding, your whole body is in trouble. You have about 5 to 6 litres of blood in your circulatory system. You can afford to lose about a half litre, as when you donate blood to a blood bank. But if you lose more than a litre, that's too much. Not enough blood is left to keep up the pressure needed to move the blood to all the cells in your body.

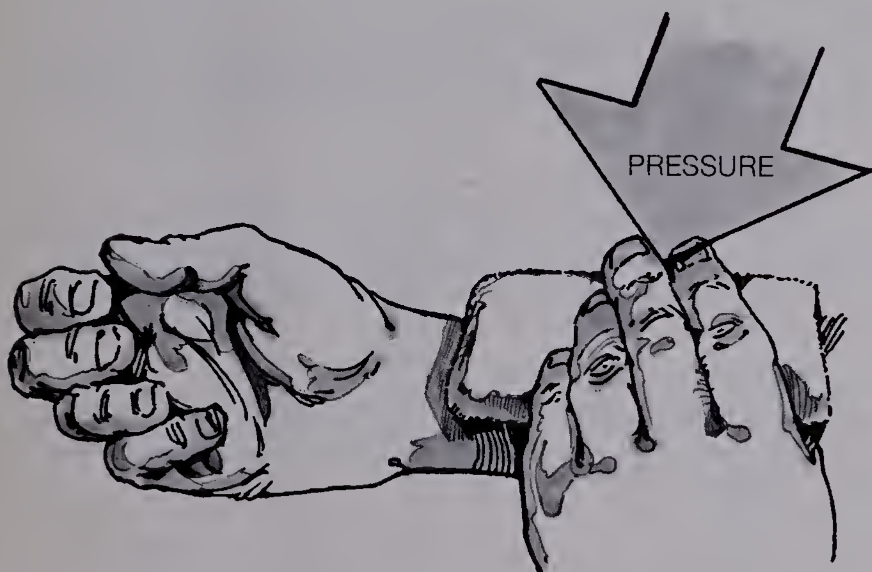


Figure 20–1

You can help prevent loss of blood. Suppose you cut yourself and the blood flows out slowly. You have probably cut a vein carrying the blood back to the heart. Apply pressure directly on the wound with a piece of cloth or sterile gauze.

Suppose you have a severe wound on the arm or leg, in which dark red blood flows fast or spurts. You have probably cut an artery. First locate a "pressure point" between the wound and the heart. Figure 20–1 shows the major pressure points in the body. These points are located on arteries that carry blood away from the heart to the body. Press the area at the pressure point against the bone beneath it. This will help slow the blood supply until direct pressure can be applied to the wound.

Never apply pressure to a vein between the wound and the heart. It would not only be useless, it would be dangerous. You don't want to stop the flow of blood back to the heart!

Avoid using the tourniquet unless bleeding cannot be stopped by any other means.

20-1. The vein is returning blood to the heart. Thus blood is still able to flow from the wound below the pressure point.

20-2. You can prevent blood from flowing back to the heart.

Emphasize the inherent danger of tourniquets.

20-3. Try to stop the bleeding by applying pressure directly to the wound with a clean cloth, or by applying pressure at the pressure point in the arm above the wound.

★ 20–1. You can stop fast and heavy bleeding by applying pressure to an artery at a pressure point. Why is it useless to apply pressure to a vein to stop bleeding?

★ 20–2. Why is it dangerous to press a vein between the heart and wound to stop bleeding?

A tourniquet tied around a pressure point is dangerous. Tourniquets should be used only in cases of severe, life-threatening bleeding that cannot be stopped in any other way. And once a tourniquet is applied, only a qualified medical person should release it. Chances are good that you'll never be in a situation that calls for a tourniquet. Almost always, blood loss can be controlled by the pressure methods described earlier.

Accidents happen. Sometimes they happen where you can't get help right away. It's a good idea to think about what you might do in advance.

✔ 20–3. Suppose you and a friend were involved in an accident far from a town or telephone. You are okay, but your friend is bleeding heavily from a gash on the right forearm. What should you do?

If you want more information on how to prevent blood loss, you might enroll in a class on first aid in your school or with the Red Cross in your area.

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HEART ATTACK

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